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WOODY PLANT SPECIES COMPOSITION, RICHNESS AND CARBON STORAGE IN DISTURBED TROPICAL RIPARIAN FORESTS

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ABSTRACT

Riparian forests play a vital role in the functioning of river systems and biodiversity protection. However, rapid land use and land cover changes due to human activities have led to their degradation and loss of valuable environmental services they offer. To plan for wise use and facilitate development of improved management strategies, it is important to understand riparian forests structure and carbon storage particularly for sites that are not fully protected. Therefore, a study was carried out to determine woody plant species composition, density, richness and above ground carbon storage in disturbed riparian forests of Morogoro, Tanzania. Thirty (30) sampling plots measuring 10 x 20 m each were laid systematically along 3 sites and all woody plant species with diameter at breast height (Dbh) of $\geq$ 1 cm identified. In total, 65 woody plant species belonging to 58 genera and 27 families were recorded. Four dominant families were Moraceae (42.2%), Apocynaceae (13%), Annonaceae (10.3%) and Phyllanthaceae (7.8%). The Dbh size class distribution showed a slight deviation from the classical inverse J distribution suggesting that both small and large sized trees are harvested. The average overall stocking density in the plots was 1598 stems ha-1 (range 250-3950) while the overall mean carbon stored in the plot was 76.5 t ha-1 (range 11.4-272.7). *Ficus exasperata*, *Syzygium cumini* and *Voacanga africana* contributed 36% of the carbon. There were no significant differences (one-way ANOVA; in all cases $P > 0.05$) in stem density, species richness and carbon stocks between sites. This study has revealed that even though the study forests are not fully protected they have high species richness, stem density and above ground carbon and therefore improved management is recommended to maintain the structure and functions of the remaining riparian forests in Kilombero.

Key words: River systems, basin, distribution, density, biomass, land use, Kilombero

INTRODUCTION

Riparian forests are unique and vital ecosystems that play a great role in the functioning of river systems and biodiversity protection (Burton *et al*. 2005, Nunes *et al*. 2019). Although often small in area, they are of extreme ecological, social and economic value and their importance is increasingly recognized as a refuge for many flora and fauna, and mitigation and adaptation option for climate change impacts. They are important ecosystems because they consist of flood-resistant species and immigrants from the adjacent uplands thereby comprising most of the regional floristic biodiversity (Pither and Kellman 2002). Moreover, they offer food and shelter for the terrestrial and aquatic fauna, therefore often recognized as areas deserving conservation. In addition, it is widely known that riparian forests play a fundamental role in the global carbon cycle and therefore help to reduce global warming. This is because riparian forests have high rates of productivity and/or the saturated conditions that favour the storage of below ground carbon in addition to the above ground carbon (Giese *et al*. 2003).

Despite immense benefits of the riparian forests, rapid changes in land use and land cover due to human activities and urbanization have led to their degradation and dwindling of important ecosystem goods and services they provide (Nunes *et al*. 2019). The land use and land cover changes are the results of continued unsustainable forest utilization and conversion of forestland into other uses like agriculture, settlement, mining and infrastructure development (Andrew and Solomon 2017, Nunes *et al*. 2019). Recently, it has been demonstrated that uncontrolled human activities and the resultant effects can cause a decline in total abundance of biodiversity by 39.5% and species richness by 76.5% and carbon stocks and habitat fragmentation (Newbold 2015). Moreover, it has also been shown that forest degradation could reduce significantly tree diversity and composition and cause more than 50% of tree species loss (Astiani 2016). In addition, it has also been reported that urbanization modifies hydrology, microclimate and facilitates introduction of invasive species (Burton *et al*. 2005). Consequently, urbanization has been linked to a permanent land use change (Zipperer 2002) and unfortunately where rural-urban development takes place the maintenance of riparian forest buffers is often ignored. Moreover, biological resources especially plant species often diminish before they can be inventoried and assessed in these important landscape units (Natta *et al*. 2002). Until recently, riparian forests remained largely ignored and unmanaged as key ecosystems in biodiversity protection and water quality management. Information on the composition, richness and carbon stocks of woody plant species occurring in the forests is critical for sustainable land management and biodiversity conservation.

While there are several studies addressing woody plant species in riparian forests, few have considered simultaneously the composition, richness and carbon stocks, in these forests particularly in Africa. There is therefore limited knowledge on how to effectively restore degraded sites and plan for wise use of these important ecosystems. Moreover, better understanding of species composition and richness on one hand and their associated carbon stocks in another hand is necessary to inform policy considerations. Therefore, this study was conducted to investigate the community structure and carbon storage of riparian forests in Kilombero catchment Morogoro, Tanzania. Kilombero catchment (which is part of Ramsar site and Important Bird Area) is undergoing rapid changes in land use and land cover due to human activities including logging for charcoal and timber, overgrazing and shifting cultivation (Mombo *et al*. 2014, Andrew *et al*. 2015). Kilombero has been taken as a case to represent many other areas with similar ecological and socioeconomic settings in Tanzania. Specifically, this study aimed to: 1) assess the spatial distribution, stem density and richness of riparian woody plant species 2) determine above ground biomass and above ground carbon storage of riparian woody plant species and 3) compare stem density, species richness and carbon stocks between 3 sites.

MATERIALS AND METHODS

Study area

The study was undertaken within Kilombero catchment which lies between longitudes 34.563° and 37.797° East and latitudes 7.654° and 10.023° South (Figure 1). It forms part of the Rufiji basin and drains a catchment area of about 40,000 km^2. The catchment contains a large floodplain that forms the largest low altitude inland freshwater wetland in East Africa (Ramsar 2019).

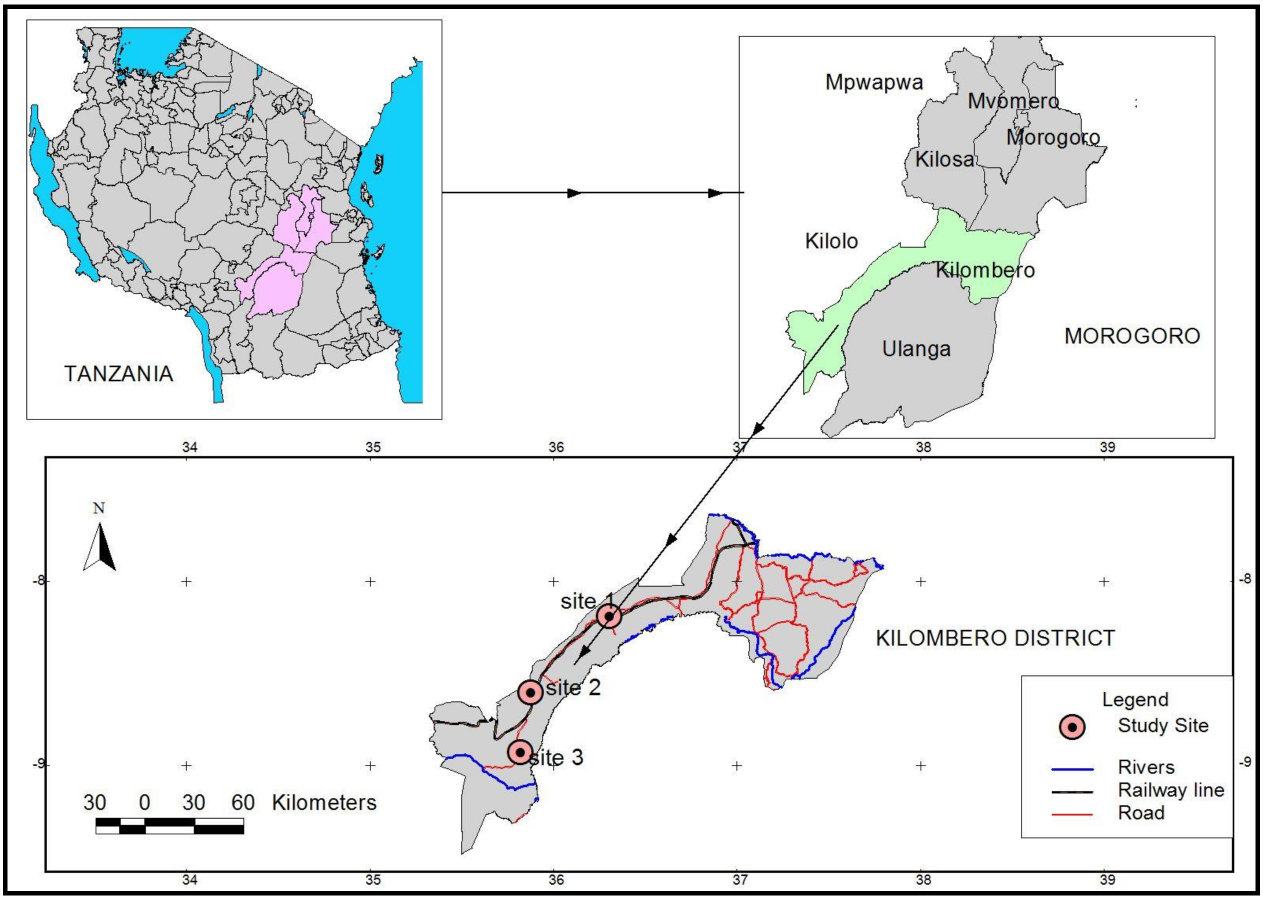

Figure 1. Map showing study sites in Kilombero, Morogoro, Tanzania

The climate in Kilombero can be described as tropical to sub-humid. There is hot wet season from December to March, cool wet season from April to June, cool dry season from July to August and hot dry season from September to November. The area has a bimodal rainfall pattern with short rains between December and February and long rains between March and May. The average annual rainfall varies between 1,200 and 1,400 mm per year in the area (Mombo *et al*. 2014). The greater part of the Kilombero consists of large alluvial plains situated at an elevation of slightly less than 300 meters above sea level (m.a.s.l.). On the basis of topography and the consequent flooding regime, the valley may further be divided into the alluvial lowlands, which are mostly swampy and subject to flooding, and the alluvial uplands, which form a strip of 6 km wide on either side of the alluvial lowlands (Yawson *et al*. 2005). Soils are deep and well-draining fertile clay soils that crack open in the dry season. Within the Kilombero catchment, there are several rivers but the study concentrated on riparian forests along the three major rivers in 3 sites (i.e., Site 1-Lwipa, Site 2-Udagaji and Site 3-Mpanga). These rivers contribute significantly to the ecohydrology of the basin and to forest cover. The Kilombero catchment hosts around 350 plant species, including indigenous species like Crotalaria polygaloides (Fabaceae), Dalbergia melanoxylon (Fabaceae) and *Aframomum alpinum* (Zingiberaceae) (Starkey *et al.* 2002). Major ethnic groups in the area are Wapogoro, Wabena, Wahehe and Wandamba. The land use in the basin includes agriculture, mining, forestry, livestock keeping, fishing, wildlife, navigation and human settlements (Mombo *et al.* 2014). According to the last data in 2005 the human population is estimated to be over 500,000 but it should be higher than that by now. During the last 2 decades there has been an increase in population and human activities resulting to intensified pressure on land and natural resources. The catchment is one of the most fertile areas in Tanzania resulting to migration of especially livestock keepers and farmers. Cattle, goats and sheep form the largest portion of domestic livestock, with cattle population estimates of 300,000 and goat and sheep of 43,000 (Mombo *et al*. 2014).

Vegetation sampling

Reconnaissance survey was made throughout the catchment area prior to the field vegetation sampling. Three sites with major rivers and riparian forests were then selected and surveyed to assess plant species composition and carbon stocks of woody plant species between November 2015 and January 2016. Thirty plots (11 plots at site 1, 8 at site 2 and 11 at site 3) measuring 10 x 20 m (0.02 ha) each were laid systematically along transects at intervals of 100 m in three sites i.e. Lwipa, Udagaji and Mpanga forests. All transects radiated from the rivers and extended perpendicular to the rivers on both sides (left and right) up to a distance of 250 m towards the floodplain where riparian forests ended. All plots were marked out or tagged with conspicuously coloured flagging tapes or stakes for easy identification of plot boundaries. Within the plot area, woody plant species with diameter at breast height (Dbh; 1.3 m above the ground) of ≥1 cm were identified, recorded and measured for Dbh using a caliper. During Dbh measurements, adjustments were made on individual plants for swollen bases, injured, fluted and crooked stems and other deformities following National Forest Resources Monitoring and Assessment for Tanzania Mainland protocol (NAFORMA 2015). For example, in case the stem of a tree was branched at breast height or below, the diameters of separate branches were measured and considered as individual trees. Moreover, if a given tree or shrub stem was buttressed, its Dbh was measured 5 cm above the buttress point. In addition, individual distances (in metres) of woody plant species from the edge of the river were measured using measuring tape. Identification of plants i.e. family, genus to species level was done in the field with the help of field guidebooks, species lists for Kilombero (Starkey *et al*. 2002) and Herbarium Curator. Species that were not identified in the field were taken to the National Herbarium of Tanzania (NHT) in Arusha for further identification and confirmation. At NHT, standard procedures for pressing and storage were observed. Correct labelling (e.g. site, plot number, date of collection and identity) of all specimens was done as required.

Data analysis

To obtain the number of woody plant species (i.e., species richness), all the species present in the plot were summed. Density was obtained by counting the number of stems per unit area (e.g. trees ha^{-1}). Biomass was computed from Dbh measurements in a standard allometric model for lowland forests (Mugasha *et al*. 2016). The allometric model used was given as $Y = 0.6881*Dbh^{1.93834}$ where Y is the biomass (kg $tree^{-1}$). This model with only Dbh was chosen to reduce error in estimation of tree height as trees in lowland have tall trees with closed canopies to which measurement of height is difficult. The amount of carbon was obtained by multiplying biomass by a conversion factor of 0.49 as recommended by MacDicken (1997). MS Excel software was used to summarize the information on composition, density, richness and carbon stocks. Comparison of stem density, species richness and carbon stocks between the sites was achieved using one-way analysis of variance (ANOVA) in R free software (R Core Team 2017). Prior to ANOVA, stem density and carbon stock data were log transformed to improve normality and homogeneity of variances. Final results were presented in form of tables and figures.

RESULTS

Species composition, stem density and richness

A total of 65 woody plant species belonging to 58 genera and 27 families was recorded in the 3 sites (Appendix 1). The overall average number of species in a plot was 7 (range 1-15). Woody species density average in sites 1, 2 and 3 were 1636, 1506 and 1627 stems ha^{-1}, respectively (Table 1). There were no significant differences in stem density (one-way ANOVA $F2, 29 = 0.118$, $P > 0.005$) and species richness ($F2, 29 = 0.355$, $P > 0.005$) between sites.

Table 1. Characteristics of study sites in Kilombero, Morogoro, Tanzania

Site	Location	Mean No. of species in plot	Mean stem density (stems ha^{-1})	Mean Dbh (cm)	Mean carbon (tha^{-1})	Species richness
1	203020E 9092862N	7 ± 2†	1636 ± 664	8.6 ± 1	72.5 ± 39	23
2	816655E 9046923N	8 ± 3	1506 ± 718	9.4 ± 1.2	75.09 ± 40.21	33
3	809896E 9010691N	7 ± 3	1627 ± 828	8.7 ± 1	81.68 ± 51.14	43

†*Mean ± Confidence interval (CI), α = 0.05*

Although the 3 sites had different plant species, the Moraceae, Sapindacea, Apocynacea and Leguminosae were recorded in all the sites (Appendix 1). *Dalbergia boehmii*, *Lonchocarpus eriocalyx*, *Voacanga africana* and Ficus species (sur, *exasperata* and *sycomorus*) were present in all the sites (Appendix 1). Sites 1, 2 and 3 had total of 23, 33 and 43 woody plant species respectively. *Ficus exasperata* had an overall abundance of 30% followed by *Annona senegalensis* with 8% (Figure 2).

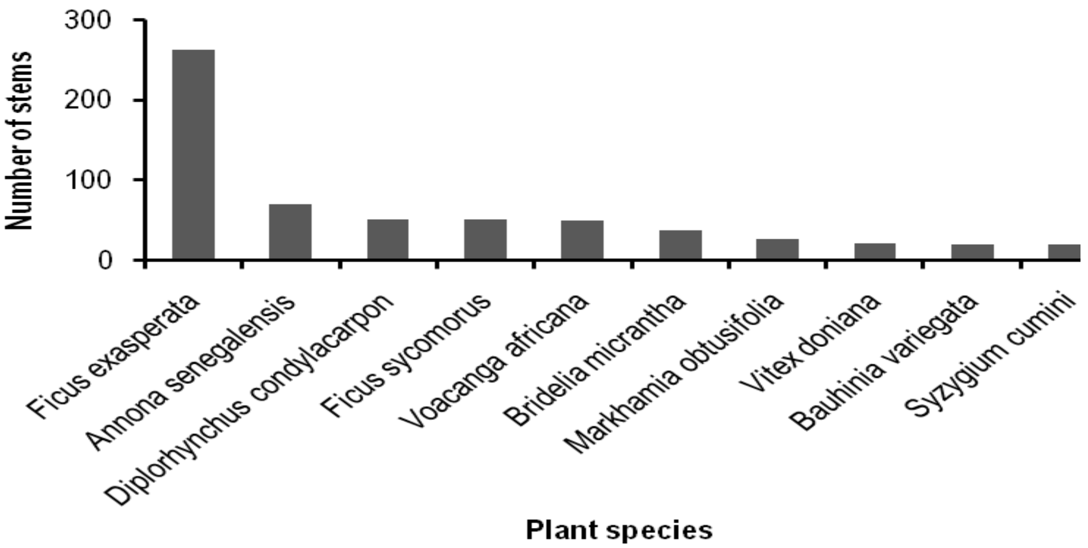

Figure 2. Abundance of top ten woody plant species in Kilombero catchment, Morogoro, Tanzania

The Family Leguminosae had the highest number of plant species (10) followed by Annonaceae (6). The overall dominant family for the 3 sites was Moraceae (Figure 3). The other families with overall high abundance were Apocynaceae, Annonaceae and Phyllanthaceae (Figure 3).

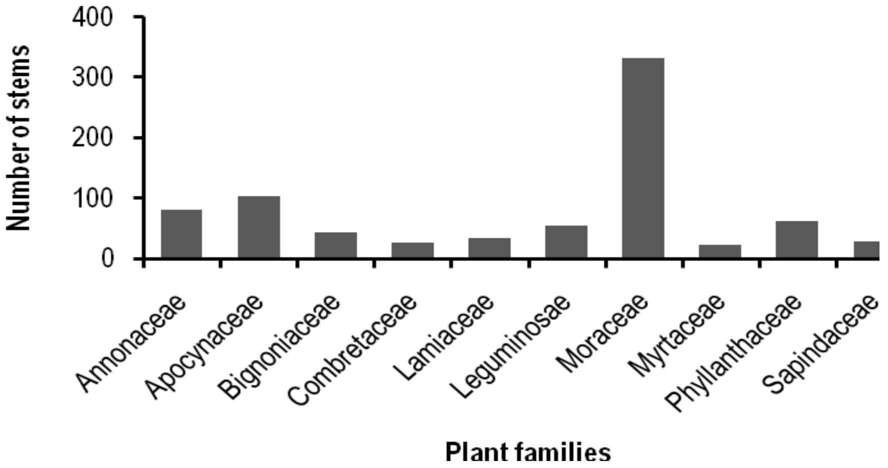

Figure 3. Abundance of woody plant species in different families in Kilombero catchment, Morogoro, Tanzania

A total of 890 stems was measured and recorded in the studied sample plots. The plots contained an overall average of 1598 ± 381 stems ha^{-1} (range 250–3900; Appendix 2). However, at individual species level, Ficus exasperate had 13150 stem ha^{-1}, Annona senegalensis 3500 stem ha^{-1}, *Ficus sycomorus* 2600 stem ha^{-1}, *Voacanga africana* 2500 stem ha^{-1} and *Diplorhynchus condylacarpon* 2600 stem ha^{-1}. In total, 49 species were distributed within the first 50 m from the three sites (Figure 4). On the other hand, the distance between 51 and 100 m had only 15 woody plant species (Figure 4).

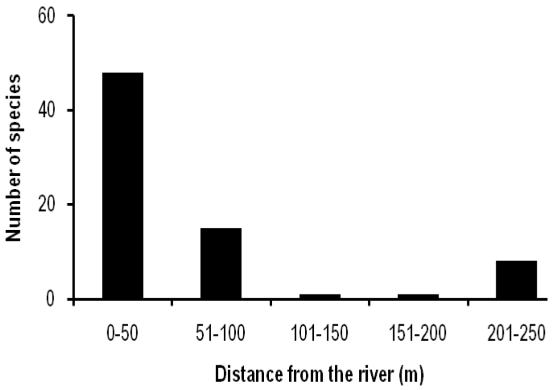

Figure 4. Woody plant species distribution in Kilombero, Morogoro, Tanzania

There were 291, 410, 89, 34, 21 and 45 stems in <5, 5-10, 11-15, 16-20, 21-25 and >26 diameter class, respectively (Figure 5). Most of the woody plant species were found to have Dbh less than 10 cm suggesting that most of these species were regenerants. There were few matured woody plant species with Dbh of ≥ 26 cm (Figure 5).

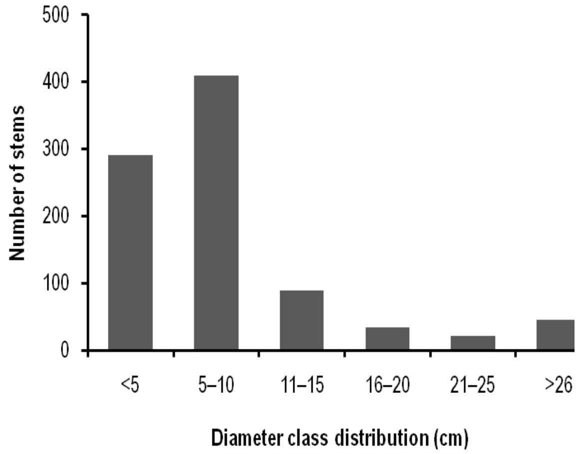

Figure 5. Diameter class distribution of the woody plant species in Kilombero catchment, Morogoro, Tanzania

Above ground carbon storage

The overall average amount of carbon in the plots was 76.54 ± 22.88 t ha^{-1}. There were no significant differences in carbon stocks between sites (one-way ANOVA $F_{2, 29}$ = 0.191, P > 0.005). Large total amount of carbon was contributed by species like *Ficus exasperata* (17%), *Syzygium cumini* (10%) and *Voacanga africana* (9%) (Figure 6) and by trees with large Dbh (Figure 7). Large contribution of *F. exasperata* to carbon stocks was due to larger coverage in the study sites. A summary of number of stems (density), biomass and carbon storage for woody plant species at plot level is included as Appendix 2.

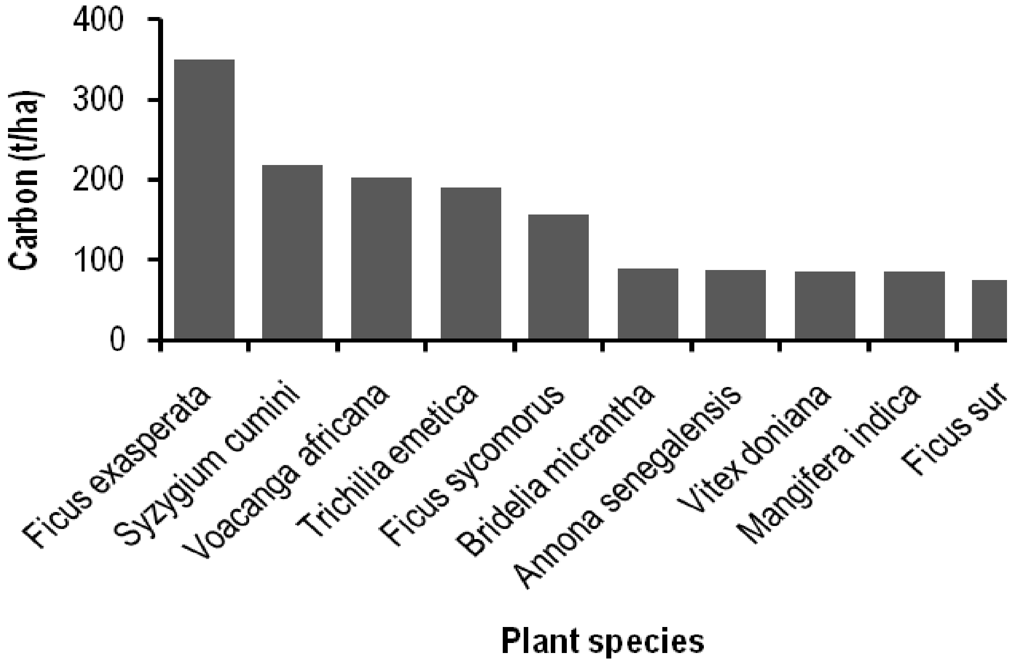

Figure 6. Total carbon storage contribution by top ten plant species in Kilombero catchment, Morogoro, Tanzania

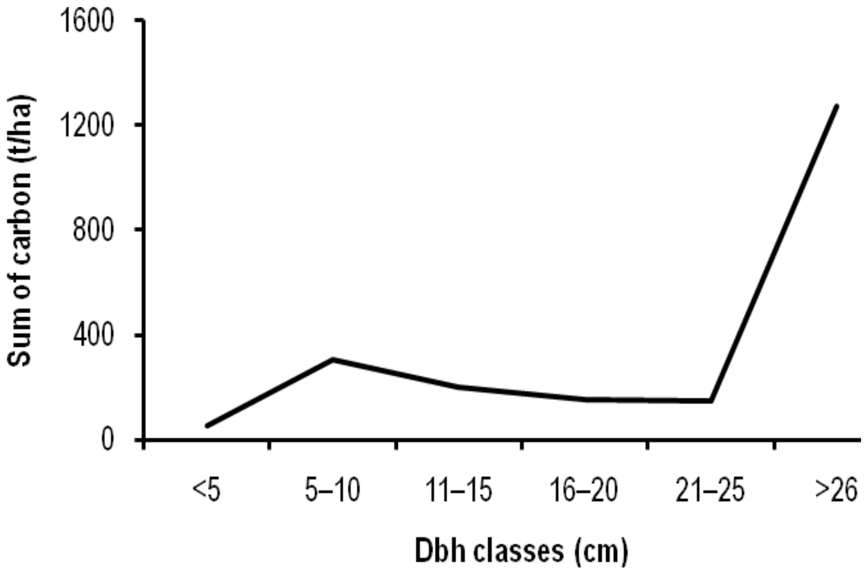

Figure 7. Contribution of different Dbh classes to carbon for woody plant species in Kilombero catchment, Morogoro, Tanzania

DISCUSSION

These results show that there is a high number of woody plant species in Kilombero riparian forests similar to other studies done in riparian forests elsewhere in the world. It is widely known that riparian forests are some of the most diverse and complex systems that harbor rich plant species important for maintenance of biodiversity, water quality and carbon storage (Wittmann *et al*. 2008, Nunes et al. 2019). The area is dominated mostly by woody plant species belonging to the family Moraceae. The overall abundance of fig tree (Moraceae) was very high in the catchment. Other plant families with high abundance were Apocynaceae, Annonaceae and Phyllanthaceae because the area has favorable ecological conditions (e.g. high nutrients, year-round available moisture and stratified sediments of varying texture) which support establishment and development of such families (Burton *et al*. 2005, Wittmann *et al*. 2008).

Most of the species (49) were distributed within 50 m of the river banks and species abundance, density and richness decreased with increasing distance away from the river. This is likely due to the influence of flooding in the study system. Flooding deposits litter, alter physical and chemical characteristics of soil and affect nutrient availability (Moran *et al*., 2008). It is indeed likely that flooding modifies physical and chemical environment which contributes to spatial heterogeneity in the plant species density, richness and composition. Spatial differences in flooding pattern create a mosaic of habitats for different plant species establishment and development (Lenssen and De Kroon 2005). The other reason for species density and richness decreasing away from the river is the human disturbance. Although low to intermediate disturbance tend to promote species abundance, density and richness (Intermediate Disturbance Hypothesis-Connel 1978), high disturbance will always affect negatively the plant community structure. In the study area there are different forms of human disturbance including logging for charcoal and timber making and overgrazing that were observed during the field surveys. Although these disturbances were not quantified studies from the areas have clearly shown that high disturbances reduce species richness, abundance and density as you move away from the river (Mombo *et al*. 2014, Andrew *et al*. 2015).

In this study, most of the plant species were observed to be in the Dbh class 1-10 cm and few species had Dbh > 15 cm suggesting that the study forests contain mostly regenerants and confirms that human disturbance is occurring in the area. These results agree well with studies which reported the tropical forests to be dominated with juvenile trees of Dbh 2-10 cm in Borneo (Singh *et al*. 2015). At Kilombero there is a greater potential for regeneration and forests recovery if human disturbance is regulated since most of the species are still growing (Suratman 2012). The average stem density per hectare recorded in riparian forests when Dbh of less than 10 cm was considered was 862 stems per hectare in Borneo (Singh *et al*. 2015). In another study in different land management areas it was reported that the average stem density varied from 635 (full protected area) to 947 (lightly protected area) stems per hectare in Tanzania (Banda *et al*. 2006). This study recorded an average of 1598 stem ha^{-1} showing that the area has a high value of stem density per hectare and that full protection does not necessarily ensure high stem density.

A Dbh size class distribution (Figure 5) shows a slight unusual trend obtained in natural forests where stem density decreases with the increase in diameter. Although a reverse J-shaped size class distribution observed in the mature forests may indicate a stable population and good recruitment of late successional species, this argument has recently been challenged due to unrealistic biological assumption of equal mortality among size classes (Isango 2007). It has been argued that declining populations may also show classic inverse J pattern and some stable populations may not show this shape due to differences in growth rates among size classes (Virillo *et al*. 2011). Lack of larger size classes may therefore likely be due to selective harvesting of such trees for timber and charcoal making in Kilombero (Mombo *et al*. 2014). Also, the presence of few small tree size classes suggests that perhaps local communities are harvesting such trees for firewood, poles and house construction as attested elsewhere (Savadogo *et al*. 2007).

It has been observed that different woody plant species have different abilities in the amount of carbon they store and sequester. This also differs spatially due to species availability, composition and size (Giese *et al*. 2003). In this study, the high amount of carbon was found in 25 tree species with Dbh ≥ 22 cm (Figure 7). These are large trees which in addition to being valuable timber species, they influence the above ground carbon storage and community structure across a range of tropical ecosystems (Silva-Costa *et al*. 2012, Singh et al. 2015). Therefore, their significant removal often changes the biomass dynamics of the forests (Saner 2009). For example, in Borneo there was a loss of up to 53% of the above ground carbon following substantial logging in lowland forests (Berry *et al*. 2010). Similarly, the removal of large trees through intensive logging had also significant impacts on species richness and composition of riparian forests in Borneo (Suratman 2012).

CONCLUSION AND RECOMMENDATIONS

This study was set to understand the community structure and above ground carbon stored by woody plant species in riparian forests of Kilombero, Tanzania. Indeed, studied riparian forests harbour abundant woody plant species with high stem density and above ground carbon stocks. Species noted to be the most abundant were *Ficus exasperata*, *Annona senegalensis* and *Diplorhynchus condylacarpon*. Besides that, the abundance of some timber tree species such as *Markhamia obtusifolia*, *Vitex doniana* and *Bauhinia variegata* were low due to over exploitation. The good news is that the study forests were recruiting new individuals and recovering from human disturbance. *Ficus exasperata*, *Syzygium cumini* and *Voacanga africana* contributed 36% of the carbon. Overall, this indicates a good sign of sustainability of the study forests and its contribution to carbon sequestration and sustainable supply of products and services communities depend on for livelihood. It should also be remembered that most of the Kilombero catchment is a Ramsar site and Important Bird Area with some form of protection. Unfortunately, the protection that is presently provided is not enough to guarantee maintenance of these forests given the current trends of population increase and land use pressure. Therefore, improved protection strategies are recommended including development of integrated land use plan (ILUP) to among other set aside riparian forests and other biological important areas for conservation. It is also recommended that thorough studies on the effects of human activities on temporal and spatial changes in species diversity and carbon stocks be conducted. Monitoring of these forests is also recommended to supplement those efforts and to ensure sustainability of the entire Kilombero catchment.

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Appendix 1: **Woody plant species composition for the 3 sites in Kilombero catchment, Morogoro, Tanzania.**

S/No.	Plant species	Family	Site 1	Site 2	Site 3
1	*Acacia polyacantha*	Leguminosae		x	x
2	*Albizia versicolor*	Leguminosae	x		
3	*Allophylus melliodorus*	Sapindaceae		x	x
4	*Annona muricata*	Annonaceae	x	x	
5	*Annona senegalensis*	Annonaceae		x	
6	*Anthocleista grandiflora*	Gentianaceae		x	x
7	*Antidesma venosum*	Phyllanthaceae			x
8	*Bauhinia variegata*	Leguminosae	x	x	
9	*Brachystegia boehmii*	Leguminosae		x	x
10	*Bridelia micrantha*	Phyllanthaceae		x	x
11	*Byrsocarpus orientalis*	Connaraceae	x		x
12	*Combretum molle*	Combretaceae	x		x
13	*Combretum zehyeri*	Combretaceae	x		x
14	*Dalbergia boehmii*	Leguminosae	x	x	x
15	*Dalbergia melanoxylon*	Leguminosae	x		x
16	*Dalbergia nitidula*	Leguminosae	x		
17	*Deinbollia kilimandscharica*	Sapindaceae		x	
18	*Diospyros kirkii*	Ebenaceae			x
19	*Diplorhynchus condylacarpon*	Apocynaceae	x		
20	*Ficus exasperata*	Moraceae	x	x	x
21	*Ficus sur*	Moraceae	x	x	x
22	*Ficus sycomorus*	Moraceae	x	x	x
23	*Garcinia volkensii*	Clusiaceae	x		
24	*Gardenia volkensii*	Rubiaceae			x
25	*Grewia forbesii*	Malvaceae			x
26	*Harrisonia abyssinica*	Rutaceae		x	x
27	*Holarrhena pubescens*	Apocynaceae			x
28	*Hymenocardia acida*	Phyllanthaceae			x
29	*Kigelia africana*	Bignoniaceae			
30	*Lannea triphylla*	Anacardiaceae			x
31	*Lethowian thusstellatus*	Annonaceae		x	
32	*Leucaena leucocephala*	Leguminosae			x
33	*Lonchocarpus eriocalyx*	Leguminosae	x	x	x
34	*Majidea zanguebarica*	Sapindacea			x
35	*Mallotus oppositifolius*	Euphorbiaceae		x	
36	*Mangifera indica*	Anacardiaceae		x	x
37	*Margaritaria discoidea*	Phyllanthaceae		x	x
38	*Markhamia obtusifolia*	Bignoniaceae		x	x
39	*Mimulopsis solmsii*	Acanthaceae			x
40	*Ophrypetalum odoratum*	Annonaceae		x	
41	*Pachystela brevipes*	Sapotaceae			x

42	*Phoenix reclinata*	Arecaceae		x	
43	*Phyllanthus fischeri*	Phyllanthaceae		X	
44	*Psidium guajava*	Myrtaceae		x	
45	*Pterocarpus angolensis*	Leguminosae	x		
46	*Ricinus communis*	Euphorbiaceae	x	x	
47	*Rourea boiviniana*	Connaraceae			x
48	*Senna siamea*	Leguminosae			x
49	*Senna sp.*	Leguminosae	x		
50	*Sorindeia madagascariensis*	Anacardiaceae	x		x
51	*Sterculia apendiculata*	Sterculiaceae			x
52	*Stereospermum kunthianum*	Bignoniaceae			x
53	*Strychnos cocculoides*	Loganiaceae	x	x	
54	*Strychnos madagascariensis*	Loganiaceae		x	x
55	*Syzygium cumini*	Myrtaceae			x
56	*Tectona grandis*	Lamiaceae	x	x	
57	*Terminalia sericeae*	Combretaceae			x
58	*Trema orientalis*	Cannabaceae		x	
59	*Trichilia emetica*	Meliaceae			x
60	*Uvaria kirkii*	Annonaceae			x
61	*Uvariodendron sp.*	Annonaceae			x
62	*Vangueria infausta*	Rubiaceae			x
63	*Vitex doniana*	Lamiaceae	x	x	x
64	*Voacanga africana*	Apocynaceae	x	x	x
65	*Zanha africana*	Sapindaceae		x	

Appendix 2: Number of stems (density), biomass and carbon storage for woody plant species in Kilombero catchment, Morogoro, Tanzania.

Site	Plots	Number of stems/ha, N	Basal area, G (m^2/ha)	Biomass (t/ha)	Carbon (t/ha)
I	1	700	3.0	23.2	11.4
	2	850	4.7	35.1	17.2
	3	850	34.0	228.6	112.0
	4	650	6.1	45.8	22.5
	5	1600	25.8	179.8	88.1
	6	550	3.4	25.8	12.6
	7	2850	52.6	372.2	182.4
	8	2300	20.8	150.9	73.9
	9	3200	39.7	282.9	138.6
	10	1750	30.4	221.3	108.5
	11	2700	7.8	60.8	29.8
Sub average		**1,636**	**20.8**	**147.9**	**72.5**
II	1	450	4.8	36.0	17.7
	2	1150	18.6	134.4	65.9
	3	1700	17.1	124.8	61.1
	4	800	20.0	143.9	70.5
	5	1200	50.0	347.2	170.1
	6	3200	32.2	229.8	112.6
	7	1400	7.7	58.5	28.6
	8	2150	20.8	151.3	74.1
Sub average		**1506**	**21.4**	**153.2**	**75.1**
III	1	250	12.1	84.8	41.6
	2	2850	10.1	77.6	38.0
	3	700	47.0	328.6	161.0
	4	1300	12.6	93.4	45.7
	5	3950	4.4	35.4	17.4
	6	2500	15.9	118.4	58.0
	7	1450	82.5	556.5	272.7
	8	2900	20.7	154.3	75.6
	9	950	30.3	212.7	104.2
	10	800	2.8	21.8	10.7
	11	250	21.4	150.1	73.5
Sub average		**1627**	**23.6**	**166.7**	**81.7**
Grand average		**1598**	**21.9**	**156.2**	**76.5**