SURVEY OF TREE SPECIES IN BAGALE HILL FOREST RESERVE OF ADAMAWA STATE, NIGERIA

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ABSTRACT
The tree species found in the Bagale Hill Forest Reserve in Adamawa State, Nigeria, were included in this study. This checklist was created after a thorough field survey was conducted with the goal of investigating the simultaneous depletion of flora and inventory of all tree species. The study region was divided into three and numerous plots, with samples gathered at random from each plot and identified using native flora. In the study region, there were 7 different species of woody trees from 17 different families. The results revealed that one family has only one species, four families have eight species each, two families have ten species each, and two more families have five species each, while the remaining families have seventeen species, thirty-three species, and twenty-three species, respectively. The Combretaceae family has the highest frequency (33 species), accounting for 19.41% of the total species counted and occurring in all plots, followed by the Caesalpiniodeae family with 23 species (10.45%). This finding reveals a high rate of flora species degradation as a result of habitat conversion into residential areas, urbanization, indiscriminate logging, and degradation and reclamation of reserves for the development of various infrastructural facilities to satisfy insatiable human wants and subsistence farming. However, in order to be sustainable, many species today require high conservation priorities.
Key words: Survey, Trees, Species, Hills, family

INTRODUCTION

Nigeria's forest systems provide a once-in-a-lifetime chance for forest conservation and ecological research. The majority of Nigeria's territory is covered with forest. Recognizing this potential, Nigeria's forest reserve system established forest reserves in all of the country's states. These forest reserves provide great examples of Nigeria's natural ecosystems for long-term preservation, education, and study (Kabiru, 2008). Long-term management of forest ecosystems necessitates a thorough grasp of both the reserve's resources and the forest's dynamic processes across time. Long-term monitoring is widely regarded as an effective method of capturing both the static aspects of natural ecosystems and the dynamic activities that occur within those ecosystems. Nigeria is home to a diverse range of plant species found in its vast forests and grasslands thanks to its unique forest systems. It is home to 7,895 plant species, making it one of the continent's most diverse countries in terms of biodiversity (Pelemo *et al.*, 2011). These environments, however, are threatened by rising civilization and other unsustainable anthropogenic activities, and the population's attitude toward conservation is rather weak, resulting in the inevitable loss of genetic resources at all levels. According to the IUCN (2010), biodiversity conservation is supposed to be an inherent responsibility of all humanity, but this is far from the case, as the rate of destructive anthropogenic activities on flora and biodiversity at large continues to rise on a daily basis, with nearly 90% of the forest in Nigeria being destroyed (Kabiru, 2008; Batta *et al.*, 2013; Momoh, 2011). Nigeria has 9 million hectares of forest, with 336,000 hectares of primary

forest, according to FAO (2010). However, several authors, including Pelémo *et al.* (2011) and Ladipo (2010), have expressed concern about the rate of deforestation in the country, which is estimated to be 3.5 percent per year, resulting in the loss of 350,000–400,000 ha of forest land per year, and the total forest land area in Nigeria is now around 10%, well below the FAO's recommended national minimum of 25%. Pelemo *et al.* estimate that roughly 484 plant species in 112 families of 7895 plant species in the country are threatened with extinction as a result of this (2011). A tree, according to Seth (2002), is a large, long-lived woody plant that reaches a mature height of at least 6 m (20 ft) in a given location and has a single primary self-supporting stem called a trunk or a bole that gives forth spreading branches, twigs, and foliage to form a crown. Nigeria had about 560 tree species, according to Ihenyen (2009) and Keay (1989). However, the continued existence of many tree species is under threat, as deforestation, logging, and other unsustainable activities have expanded dramatically in recent years, putting several species at risk of local extinction. The tree species observed in the research region are not immune to the aforementioned concerns. Rapid population growth has resulted in the development of several infrastructure facilities to meet human needs, which has, of course, resulted in the destruction of vegetation in the study area and its surrounding vegetation for urbanization and other human activities, which are socioeconomic issues that are difficult to control. There was no attempt to compile a list of the tree species found in this area. As a result, a complete checklist of plant species is required in order to decide on appropriate conservation measures that would benefit future generations. As a result, the purpose of this work is to provide a checklist for all of the trees in the study area.

MATERIAL AND METHODS
Study area
The study was conducted in Bagale Hill Forest Reserve, Adamawa State, Nigeria. The area which is bordered with the republic of Cameroon to the East, Song Local Government Area to the North and Yola South to the West and South. It is located on longitude 12.35' E and latitude 9.3° N and on elevation of 339m (Adebayo *et al.,* 2004). The landscape of the reserve is dominated by extensive flood plain as River Benue flows southeast of the reserve. The reserve covered a total land area of 179.746 sq. km (Figure 1).

Data Collection
Data were collected in 17 plots located in the three study sites and distributed as follows: 5 in Tudun Wada, 4 in Wuro Dole and 8 in Lugga. The numbers of plots are in proportion to the area of the Forest Reserve. Each plot consists of four circular plots: a central plot (plot1) surrounded by three plots in the form or shape of an inverted Y (Figure 2). Each plot is 7.32m in diameter (0.017ha) and of the three surrounding plot is 36.6m away from the centre of plot1. In Tudun Wada and Wuro Dole forests, two plots that are located in the hilly area were selected randomly. From each plot, plot 1 and plot 2 were chosen randomly out of the four plot in a cluster constituting a plot for vegetation measurement. In Tudun Wada, a third plot was sampled in addition to plot1 and 2. In the case of Lugga forest, four plots were laid out and eight plots were used for sampling the vegetation data. Boths plots that were sampled in Lugga were relatively higher than in both Tudun Wada and Wuro Dole.

At each plot all tree species were enumerated and recorded by species and size class: individuals plants with diameter at breast height (DBH) >10cm and height >1.3m were classified as trees, individuals with a DBH <10cm but height >1.3m were classified as saplings and individuals with height <1.3m were classified as seedlings. The diameters at breast height DBH of the tree were measured. The measurement of circumference and the tree height were made by the use of Spiegel Relascope..In this study identification of Nigerian floral species was done primarily via comprehensive secondary data of plant records in books, reliable internet resources and herbarium collections, performed between July to August 2015. The books used were Trees of Nigeria (Keay, 1989); second and revised edition of Flora of West Tropical Africa (FWTA), volume 1 (parts 1and 2). Furthermore, the botanical names were based on the African Plants Database (2009).

Data Analysis

Woody species diversity and density

The tree species diversity was computed using Shannon-Wiener index as described by Badgal, Shannon-Wiener Index $H' = \sum p_1 \ln(p_1)$

Where i is the proportion of the species relative to the total number of species (pi) multiplied by the natural logarithm of this proportion (ln pi) and the final product multiplied by -1. The Shannon-Wiener index typically ranges from 1.5 to 3.5 and rarely reaches 4.5. Gaines et al. (1999).

Density

Species Density, which refers to the number of individuals of a species per unit area is given as: Species Relative density $RD = \frac{n_i}{N} \times 100$

Where: RD = Relative density

ni = Number of individual species

N = Total number of all individuals in the entire population

Important value index

Importance value make inferences about the potentials of stands, soil condition, moisture regime and the general ecology of the site and is computed as given by Brashears *et al.,* (2004)

$$IVI = \frac{RD + RDo}{2}$$

Where RDo is Reative dominance

RDo (Reative dominance) $= \frac{TotalBasalAreaofIndividualspecies}{TotalBasalAreaofallspecies} \times 100$

RESULTS AND DISCUSSION

A total of 37 woody species belongs to 17 families were encountered across the 17 plots as shown in Table 1. Combretaceae was the most ecological dominant family, followed by Caesalpiniodeae and Anacardiaceae. in that order. Tree/shrub species in the study sites indicated relative selectivity in which they occurred as only few species precisely *Combretum glutinosum, Pterocarpus erinaceous* and *Sclerocarya birrea* were present in all the 17 plots. The species of tree/shrubs identified were, *Sclerocarya birrea, Dichrostachys cinerea, Combretum glutinosum, Parkia biglobosa, Haematostaphis barteri, Lannea acida, Detarium microcarpum, Piliostigma thonningii* and *Ziziphus abyssynica.* Others are *Azadirachta*

indica, Terminalia avicennioides, Strychnos innocua, Vitellaria paradoxa, Annona senegalensis, Tamarindus indica, Lannea schimperi, Balanite aegyptica, Albizia zygia, Daniellia oliveri, Cassia singueana, Afzelia africana, Burkea africana, Acacia nilotica, Grewia venusta, while others identified are *Stereospermum kunthianum, Diospyros mesipiliformis, Adonsonia digitata,, Ziziphus spina-christi and Fiscus polita* (Tabke 2). At T/Wada 20 tree/shrub species were identified. At the third site (Wuro Dole) a total of 15 species were identified and these tree species are *Acacia nilotica, Vitex doniana, Boswelia dalzielii, Anogeissus leiocarpus, Piliostigma reticulatum, Annona senegalensis, Ziziphus absynica, Daniellia oliveri, Combretum glutinosusm.* Others tree species were *Tamarindus indica, Commiphora Africana, Terminalia avicennioides, Sterculia setigera, Strychnos innocua and Piliostigma thonningii, Entda africana, Dichrostachys cineria, Ziziphus mauritiana and Sclerocarya birrea.*

The diversity index H^1 for species nativity in Lugga, Tudun Wada and Wuro Dole is, 2.60, 2.23 and 1.28 respectively. Thus this statistics illustrate the great numbers of trees plants that have become established in Lugga habitats, with more being expected every year. Of all the families encountered, eleven families were recorded to have only 1 species each, two families have 3 species each while the other families consists of 7 species, 6 species, 4 species and 2 species respectively. Of these, the family Combretaceae has the highest frequency (7 species) occurring in all the plots followed by Caesalpiniodeae which consists of 6 species

The distribution pattern of the tree species reveals total dominate in the species number, with the highest densities of occurrence recorded in Lugga whereas some sampling site were observed to be stocked with few tree, and the entire vegetation in such locations is seriously been destroyed as result of unsustainable human activities. It is believed that before the establishment of the reserve, the biodiversity of Bagale Hill Forest Reserve was covered with huge of tree forest, but the rapid urbanization from the 1970s onwards that followed a series of successive redevelopments for higher intensity land use, which have culminated, and is escalating in an unprecedented manner. Although the main drivers of deforestation in the country as outlined by Pelemo, *et al.* (2011) include agriculture, use of fuel wood and logging amongst others, these pose various degrees of threats to biodiversity conservation in Nigeria. However, in this study, habitat conversion into residential area (urbanization), indiscriminate degradation and reclamation of the reserve for development of several infrastructural facilities in order to satisfy humans wants, and subsistence farming were observed to be the stringent problems facing the flora of this area (Figures 1 and 2). In fact, some part of the reserve (fringes) in the study area has been degraded such that the secondary vegetation are cleared to build public housing or infrastructures.

However, these problems could be exacerbated by the influx of human population and students population of the nearby Modibbo Adama University of Technology in Girei, where the study area is situated, and is inextirpable, and now is considered the fast growing area in Adamawa State in terms of Infrastructure and human population. The increase in population often leads to enrolling of more students into the institution, especially as it is considered the "institution of first and second choice" in the northeast zone as catchment area, and this has resulted into developing of more infrastructural facilities for conducive accommodations for students. Consequently, this encourages continuous degradation of the vegetation to pave

way for these infrastructural facilities which jeopardize the existence of the tree species found in this area. This finding is in line with Badgal *et al.* (2014) who observe that increase in population around the reserve made people to encroach into the forest. Today, Bagale Hill Foreset Reserve floras is growing in a mosaic of surviving primary vegetation and patches of low secondary vegetation, with more visible plants as wild species. In fact the species of *Sclerocarya birrea* have almost declined in numbers as result of constant felling for structure development, and the decimation of such habitats caused by unsustainable management pose a great challenge to the survival of biodiversity in this forest. Some of the plants that are endemics to coastal environments, such as *Sclerocarya birrea,* and *Pterocarpus erinaceous*are now known from few sites unlike it was before and now need high conservation priority. This checklist summarizes that a total of 37 woody tree species belonging to 17 families were encountered across the 17 plots. Combretaceae was the most ecologically dominant family, followed by Caesalpiniodeae and Anacardiaceae. At Tudun-Wada, 20 tree and shrub species were identified. Deforestation in Nigeria is escalating in an unprecedented manner. Bagale Hill Forest Reserve was once covered with a huge forest of trees.

However, habitat conversion into residential areas (urbanization), indiscriminate degradation, and reclamation of the reserve for the development of infrastructural facilities pose major threats to biodiversity conservation. Bagale Hill Foreset Reserve flora is growing in a mosaic of surviving primary vegetation and patches of low secondary vegetation. Some of the plants that are endemic to coastal environments, such as Sclerocarya birrea and Pterocarpus erinaceous, are now known from a few sites.

CONCLUSION

The study provided a detailed checklist of tree species in the study area and highlighted the various anthropogenic activities posing threat to the flora of the reserve. However, it is very evident that in-situ conservation is no longer effective to conserve the trees species growing in this forest as a result of indiscriminate reclamation and various forms of degradation processes exacerbated by population growth. Hence, there is a need to deduce an effective means of conserving the species through strict enforcement of the existing law in the reserve.

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http://dx.doi.org/10.1663/0013-0001(2002)056%5B0255:ESOSPO%5D2.0.CO;2
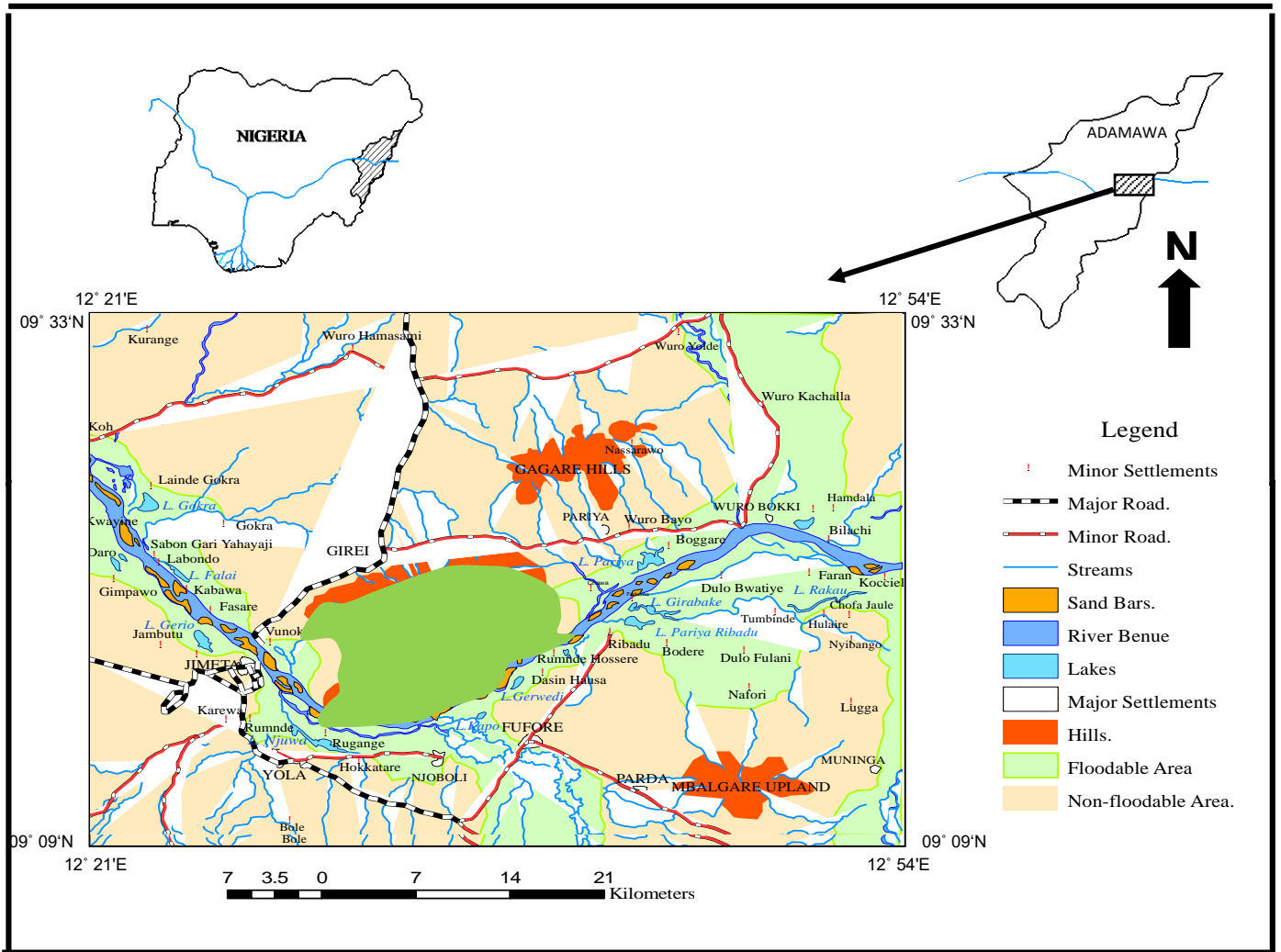
Figure 1: Map of Bagale Forest Reserve
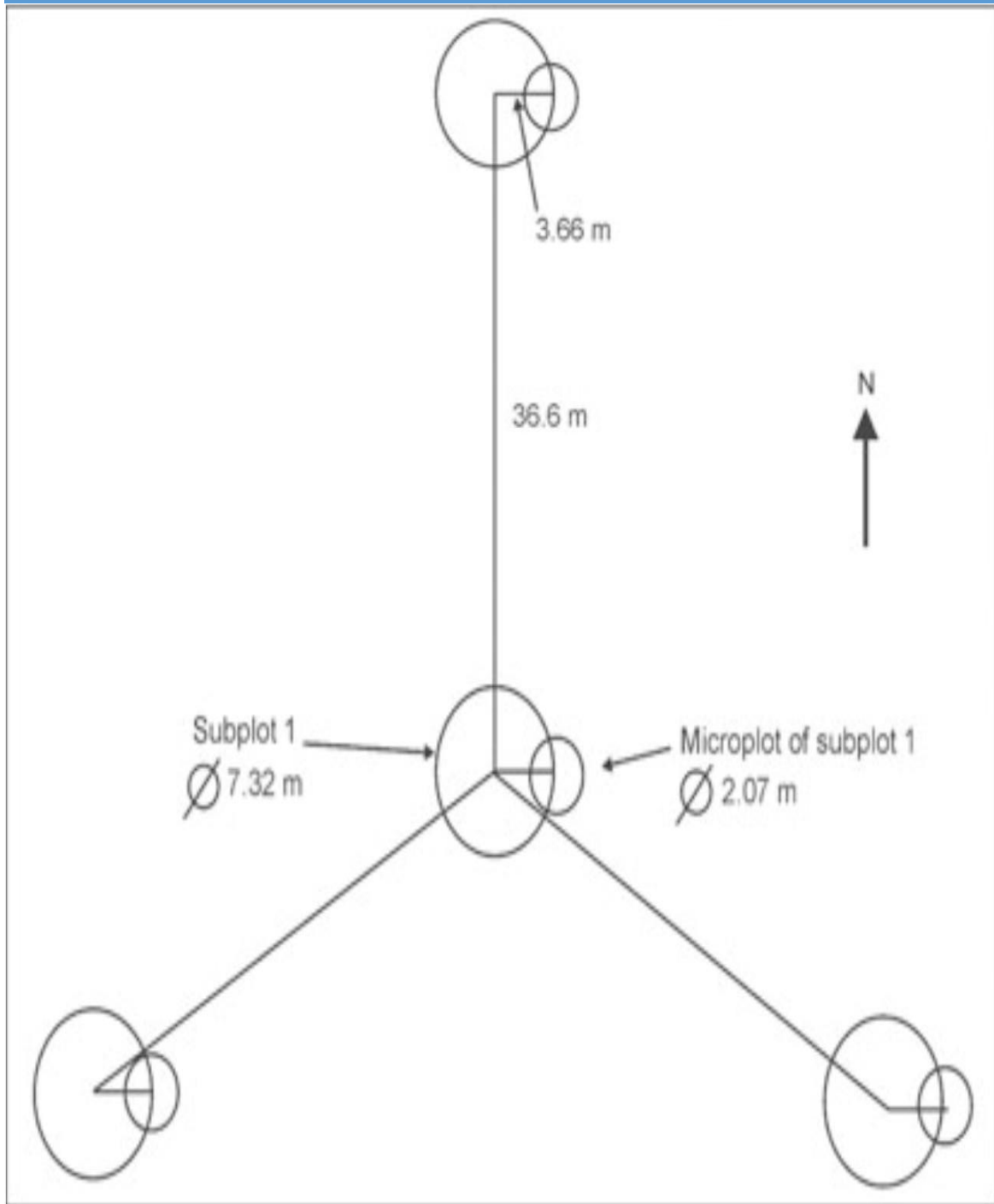Source: G.N. Tsundass Nig. Ltd

Figure 2: The layout of the plots and subplot.
Source: Adopted from USDA Forest Service (2007).

Table 1: Total number of species per family encountered in the study area

Families	Species	Lugga	Tudun Wada	Wuro Dole
Anacardiaceae	*Sclerocarya birrea, Haematostaphis barteri, Lannea acida, Lannea schimperi*	9	6	2
Leguminosae	*(Dichrostachys cinerea, Parkia biglobosa, Tamarindus indica, Detarium microcarpum, Acacia nilotica, Entada africana, Prosopis Africana*	2	3	3
Combretaceae	*Combretum gutinosum, Terminalia avicennioides, Annogeissus leocarpus*	14	13	6
Papilonoideae	*Pterpcarpus erinaceus*	3	2	3
Rhamnacea	*Ziziphus spina-christi, Ziziphus mauritiana*	3	2	3
Loganiaceae	*Strycnos innocua*	7	2	1
Sapotaceae	*Vitelaria paradoxa*	5	3	2
Caesalpinioidea	*Piliostigma thonningii, Daniellia oliveri, Cassia singuena, Piliostigma reticulatum, Burkea Africana, Afzelia africana*	9	10	4
Balanicaceae	*Banites aegyptica*	7	-	1
Annonaceae	*Annona senegalensis*	6	4	3
Verbenoceae	*Vitex doniana*	2	3	-
Hymenocardiaceae	*Hymenocardia acida*	8	3	-
Olaniaceae	*Ximenia Americana*	4	1	-
Sterculiaceae	*Sterculia setigera*		-	-
Moraceae	*Fiscus polita*	3	-	-
Burseraceae	*Boswellia dalzielii, Daniellia oliveri, Commiphora africana*	1	-	-
Ebenaceae	*Diospyros mesipiliformis*	4	-	-
Total		87	52	28

Source: Researcher Field Data (2019).

Table 2: List of Tree Species identified in the study area

Families	Species
Anacardiaceae	*Sclerocarya birrea, Haematostaphis barteri, Lannea acida, Lannea schimperi*
Leguminosae	*Dichrostachys cinerea, Parkia biglobosa, Tamarindus indica, Detarium microcarpum, Acacia nilotica, Entada Africana, Prosopis Africana*
Combretaceae	*Combretum gutinosum, Terminalia avicennioides, Annogeissus leocarpus*
Papilonoideae	*Pterpcarpus erinaceus*
Rhamnacea	*Ziziphus spina-christi, Ziziphus mauritiana*
Loganiaceae	*Strycnos innocua*
Sapotaceae	*Vitelaria paradoxa*
Caesalpinioidea	*Piliostigma thonningii, Daniellia oliveri, Cassia singuena, Piliostigma reticulatum, Burkea africana, Afzelia Africana*
Balanicaceae	*Banites aegyptica*
Annonaceae	*Annona senegalensis*
Verbenoceae	*Vitex doniana*
Hymenocardiaceae	*Hymenocardia acida*
Olaniaceae	*Ximenia Americana*
Sterculiaceae	*Sterculia setigera*
Irvingiaceae	*Irvingia gabonensis*
Burseraceae	*Boswellia dalzielii, Daniellia oliveri, Commiphora Africana*
Ebenaceae	*Diospyros mesipiliformis*

Source: Researcher Field Data (2019).