

RESEARCH ARTICLE

VEGETATION CHARACTERIZATION AND FAMILY COVER IN THREE SELECTED ECOSYSTEMS OF MARKURDI LGA, NORTH CENTRAL NIGERIA

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ABSTRACT

This work characterized the vegetation structure using tree heights, DBH (diameter at breast height) class distribution and percentage family cover of trees and herb as standard determinants of growth, production and diversity of three selected ecosystems (grazing, riparian and plantation ecosystems) in Makurdi Local Government Area of Benue State, Nigeria. Plot sampling, plant measurements and identification followed standard practices. Correlation was determined between plant height and DBH at each ecosystem using the Pearson's methods on Minitab 16 software. Consequently, tree height classes (m) 6-10 and 11-15 had the highest frequency (154) while DBH class 51-100cm was the most dominant. The riparian vegetation had the largest percentage family cover (15 families) with Fabaceae having the highest percentage (43.2%). This was followed by the grazing (9 families) and plantation ecosystems (3 families). Percentage family cover of herbs was largest in the grazing ecosystems (21 families) where family Poaceae had the largest cover (37.04%). Moderate relationship exists between height and DBH in the three ecosystems. Results provided sufficient evidences of anthropogenic pressure on the tree species. The plantation ecosystem showed signs of excessive vegetal perturbation. The information provided is crucial in the management, conservation and sustainable utilization of documented plant species on the basis of the existing vegetational physiognomy and family in the affected ecosystems.

KEYWORDS

Ecosystems, Vegetation, Characterization, Family cover, Conservation

1. INTRODUCTION

Plant biodiversity refers to the degree of variability of plant life at all levels of biological organizations (IUCN, 2024). The health of an ecosystem is determined by the level of its biodiversity. It provides numerous life support benefits including utilitarian benefits, ecosystem stability and the provision of ecosystem services (Gomez-Baggethun and Barton, 2013; Tilman et al., 2014). Anthropogenic activities have been implicated in the degradation of terrestrial ecosystems. These include climate change and green house effects, pollution emanating from industrial and agricultural activities as well as deforestation and habitat destruction due to urbanization or developmental projects (Aguoru et al., 2015a; Justin et al., 2016; Abah et al., 2020). In view of this, many plant species are critically endangered, threatened or lost. Conservation efforts by stakeholders have led to the establishment of parks and natural reserves to protect plant species and improve their status (Onen et al., 2019).

A basic principle in conservation is the characterization of vegetation in relation to growth and family cover as a measurement of the overall wellness and functionality of a particular ecosystem (Shoda et al., 2020). Accurate tree height and DBH (diameter at breast height) are important input variables for growth, yield production and management of an ecosystem. These parameters are also useful in the estimation of forest volume, biomass and carbon stock (Shoda et al., 2020; Ekasari and Kurnia, 2023). The Makurdi vegetation is rich in trees and herbs of diverse types due to the presence of favourable climatic and edaphic factors in addition

to the presence of river Benue. These factors promote terrestrial ecosystem diversity in the area.

Conservationists have advocated that regions known to be hotspot of biodiversity should be prioritized in conservation program (IUCN, 2024). However, there is dearth of information on the vegetational analysis in the selected ecosystems. Data on height, DBH class distribution and family cover are lacking. The present investigation was designed to fill this gap for the effective management of riparian, grazing and plantation ecosystems. Ecological studies of this nature would give an insight into the wellness, functionality, stability, diversity and sustainable utilization of trees and herbs. Measurements of plant heights and DBH would help predict the extent of exploitation of trees to make an informed decision on the management and conservation of the ecosystems (Dawoe et al., 2010; Capon et al., 2013).

One of the goals of the government at all levels is promote economic growth and infrastructural development (Shabu et al., 2010; Sati et al., 2017; Abah et al., 2020). Urbanization and developmental projects are on the increase in Makurdi, the State Capital of Benue State, in line with the current mandate of the present administration at the State level. This may cause the fragmentation and destruction of the prevailing ecosystems. Although it is apparent that many ecosystems are fast losing their dominant plant species, the impacts of anthropogenic activities on plant diversity of the study area were not scientifically documented in the past, thus hindering the current conservation program. The present ecological study sought to carry out a quantitative characterization of trees and herbs

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in three ecosystems in Kwaghtamen village and New cities of Makiurdi LGA. Tree heights, DBH (diameter at breast height) class distribution and ecosystems and family cover were studied.

2. MATERIALS AND METHODS

2.1 Study Area

The study was carried out in two locations: Kwaghtamen village and New City in Makurdi Local Government Area of Benue State as indicated in the

study map (Figure 1). The choice of the two locations within the same geographical axis (latitude $7^{\circ} 44' 01''$ N and longitude $8^{\circ} 31' 17''$ E) was due to the existence of three terrestrial ecosystems in the area. The area falls within the guinea savanna agro-ecological zone of Northcentral Nigeria. Makurdi, the State Capital of Benue State, lies on the south bank of the Benue River. It experiences a tropical climate with prominent wet and dry seasons characterized with an average annual rainfall of 1290mm (Akintola, 1986) and daily temperature of 40°C maximum and a minimum of 22.5°C (Ekhuemelo et al., 2019).

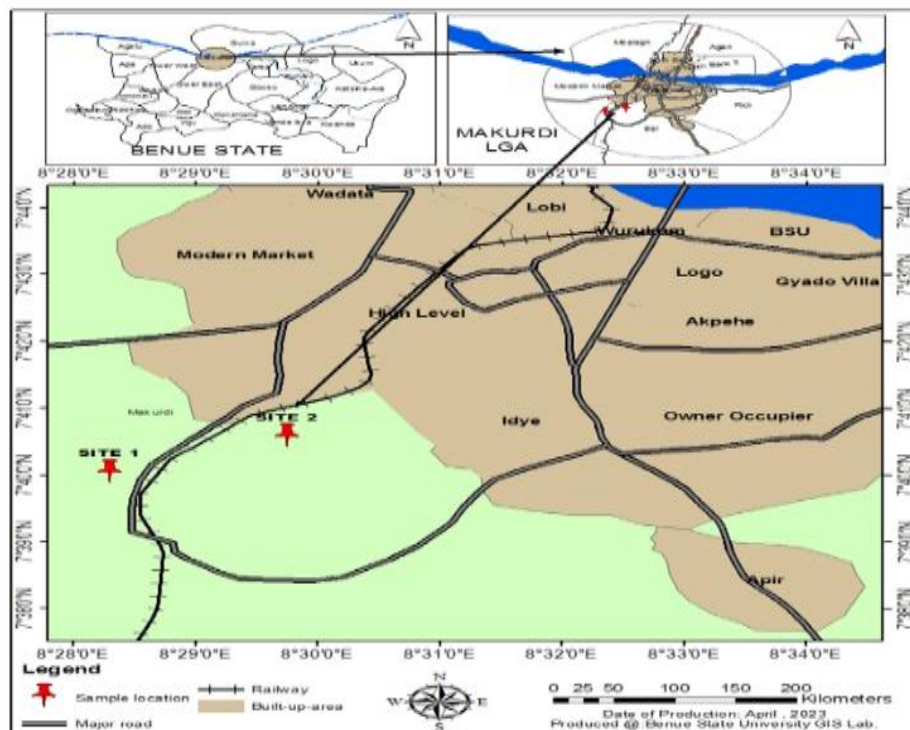


Figure 1: Map of Makurdi Showing the Study Areas

2.2 Plant Sampling

Three ecosystems (grazing, riparian and plantation ecosystems) were identified and studied between March and December, 2022. In each ecosystem, seven (7) randomly sampled plots of 100 m x 100m were mapped out using the GPS (Geographic Positioning System) following standard practices (Justin et al., 2016; Onen et al., 2019). The line transect method was employed. In each of the plots, all trees and shrubs were counted. Sampling of herbs was done using the quadrats (1m x 1m) thrown at 5 points per plots. Collection of litter was done following standard practices (Gemedo et al., 2006; Nguyen et al., 2014).

2.3 Plant Identification

Plants were identified using standard plant identification guide, flora and monographs of West Africa as well as internet aide (Aguoru et al., 2015b). Taxonomists were consulted to authenticate all unidentified plants in the Department of Botany, Joseph Sarwuan Tarka University Makurdi. Collected plant specimen were prepared following standard herbarial practices (Aguoru et al., 2015b). Type specimen were deposited in the mini-herbarium of the above-named institution where voucher numbers were issued accordingly.

2.4 Data Collection and Analysis

Plant height measurement was undertaken using the Haga altimeter. Trees were grouped on the basis of their heights (1-5m, 6-10m, 11-15m, 16-20m and >21m). Tree diameter at breast height (DBH) was measured using the measuring tape in cm and it was taken at 4.5 feet above the ground as the standard practice (Shoda et al., 2020; Ekasari and Kurnia, 2023). Plants were grouped into their various families with their frequencies and percentage cover. Correlation analysis was employed on the Minitab 16 software using the Pearson's methods. Coefficient of correlation was established between plant height and DBH at each ecosystem.

3. RESULTS AND DISCUSSION

3.1 Height and DBH Class Distribution at Riparian, Grazing and Plantation ecosystems

Tree height classes (m) 6-10 and 11-15 had the highest frequency followed by class 1-5 with class 16-20 and 21 and above being the least respectively. The DBH class 51-100 was dominant, followed by 101-150cm, 1-50cm, 151-200cm and 201 and above respectively (Table 1).

3.2 Percentage Family Cover of Trees

Tree species percentage family cover indicated that riparian vegetation had the highest percentage family cover accounting for 15 different families with Fabaceae showing the highest percentage (43.22%) followed by Lamiaceae (13.56%) with Combretaceae, Anacardiaceae, Aquifoliaceae and Annonaceae being the least with a percentage cover of 0.85% each (Figure 2). This was followed by grazing plot with 9 different families where Fabaceae was the highest (60%) while Sopataceae and Combretaceae had the least with 1% each (Figure 3). Plantation ecosystem had the least family percentage cover showing only 3 different families namely Fabaceae, Lamiaceae and Verbenaceae (Figure 4).

3.3 Percentage Family Cover of Herbs

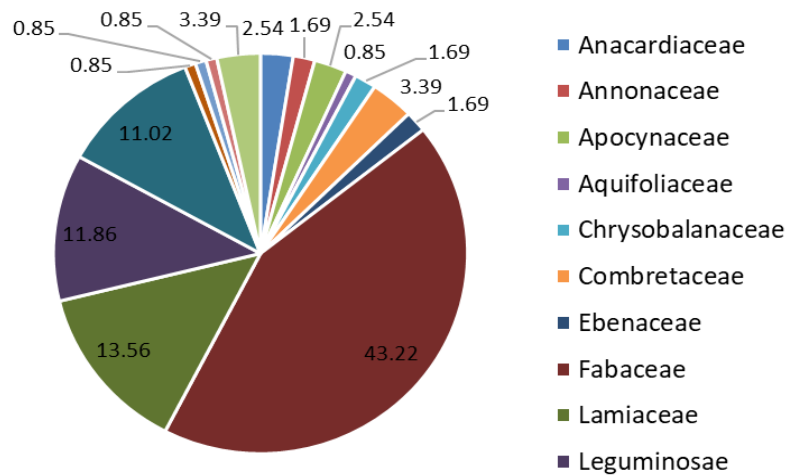
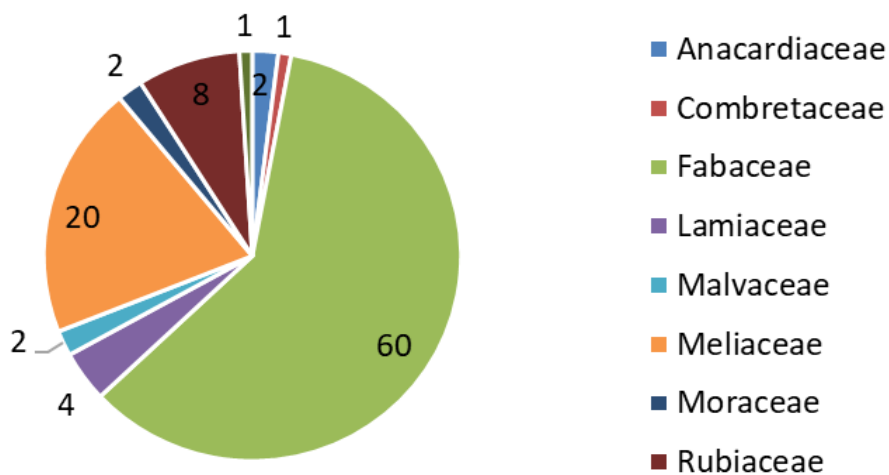
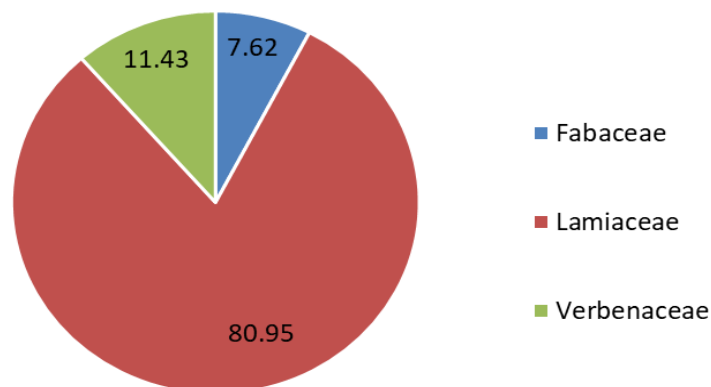
Percentage family cover of herbs was highest in riparian and grazing plot with 17 and 21 different families respectively, with family Poaceae displaying the highest percentage cover of 28.57% and 37.04% respectively (Figure 5-6). Plantation plot had the least percentage family cover (Figure 7).

3.4 Correlation Between Height and DBH

Tree species correlation analysis in grazing plot reveal that There was moderate positive correlation between height and DBH ($R = 0.411$) (Figure 8). In plantation plot, Height (m) and DBH (cm) showed a positive moderate correlation ($R = 0.454$). In riparian plot Height (m) and DBH (cm) correlated moderately ($R = 0.582$) (Figure 9)

Table 1: Height and DBH class distribution of Kwaghtamen riparian, grazing and new city plantation ecosystems.

Height class (m)	Frequency	DBH class (cm)	Frequency
1-5	27	1-50	34
6-10	154	51-100	159
11-15	125	101-150	86
16-20	13	151-200	32
21 and above	2	201 and above	10

**Figure 2:** Tree species percentage family cover in riparian plot in Kwaghtamen village Makurdi, Benue State Nigeria.**Figure 3:** Tree species percentage family cover in grazing plot in Kwaghtamen village Makurdi, Benue State Nigeria.**Figure 4:** Tree species percentage family cover in plantation plot in Kwaghtamen village Makurdi Benue State Nigeria.

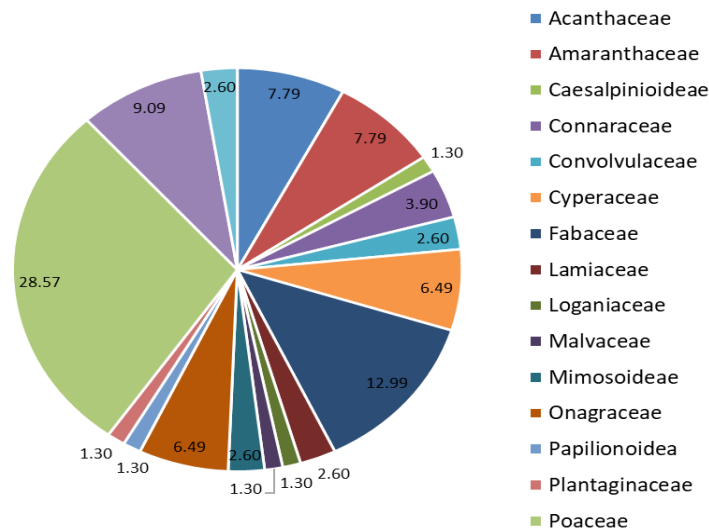


Figure 5: Herbs species percentage family cover in riparian plot in Kwaghtamen village Makurdi, Benue State Nigeria.

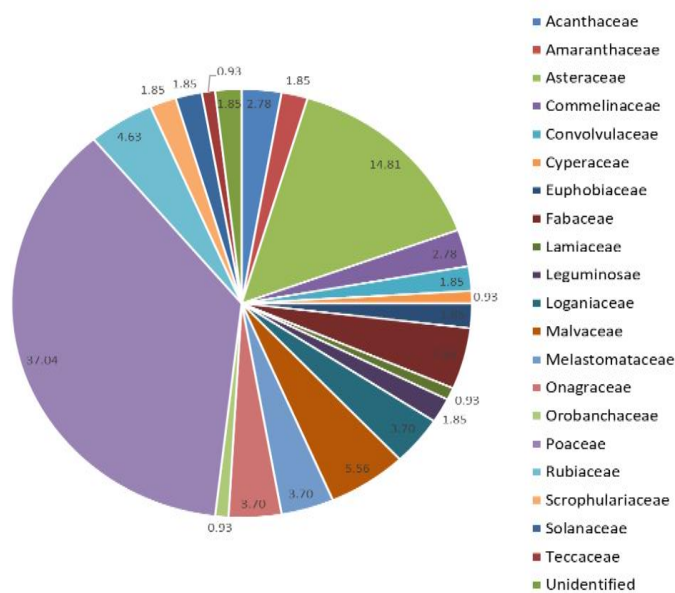


Figure 6: Herbs species percentage family cover in grazing plot in Kwaghtamen village Makurdi, Benue State Nigeria.

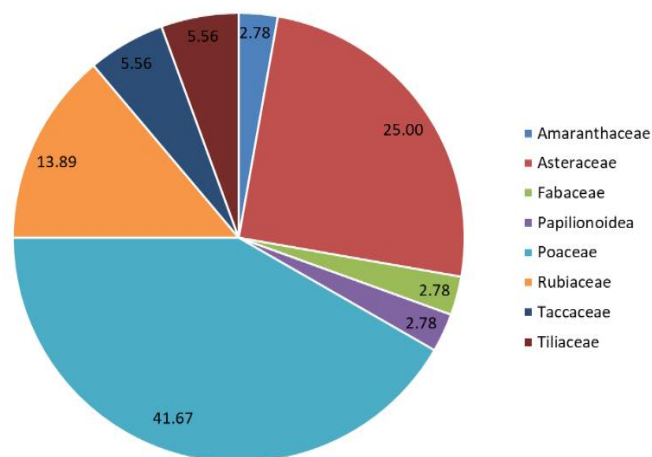


Figure 7: Herbs species percentage family cover in plantation plot in Kwaghtamen village Makurdi, Benue State Nigeria.

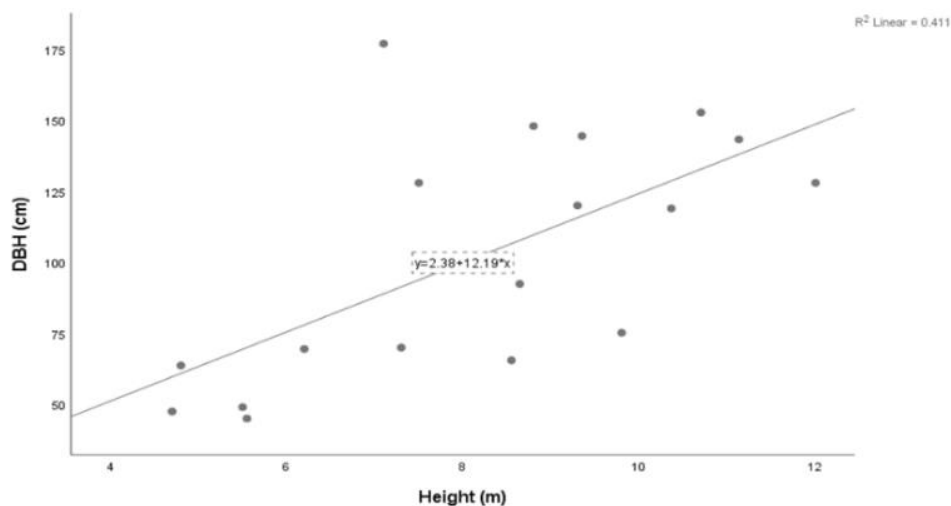


Figure 8: Regression plot between height and DBH in grazing ecosystem

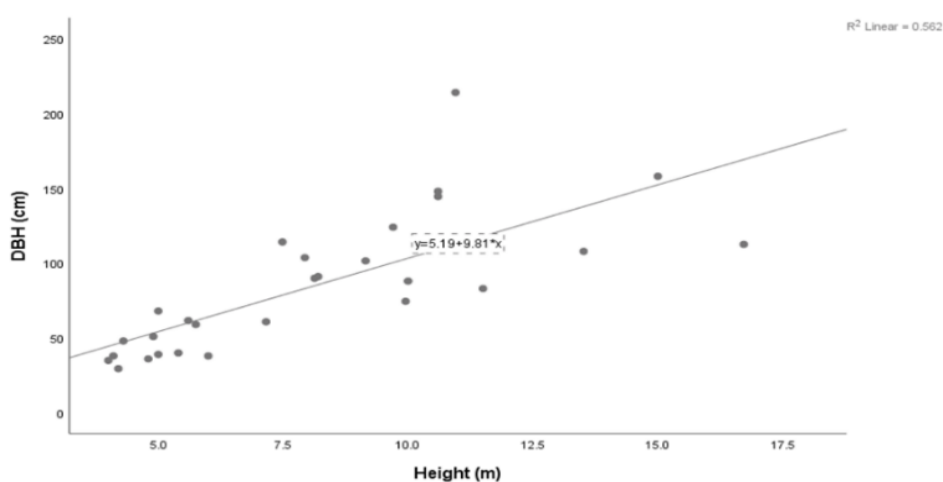


Figure 9: Regression plot between tree height and DBH in riparian ecosystem

4. DISCUSSION

The study has successfully characterized the three ecosystems (riparian, grazing and plantation) by dissecting the height, DBH and family cover of tree and herbs species.

Therefore, the present study has reported the dominance of short trees of 6-15m with narrow diameter (51-100cm) while classes above this range were few. This result suggests the presence of anthropogenic pressure on the trees reported as short in height with narrow diameter. This outcome could be due to continued deforestation and logging activities in the ecosystems in agreement with the work by Chen and Cao (2014) who reported the impacts of deforestation on understory plant species diversity.

Measuring the tree diameter at breast height is a standard method used in forestry and ecology to assess the size and growth of trees. The significance of this characterization includes tree growth monitoring, estimation of tree volume and biomass, age estimation of trees, species identification and health assessment of trees (Shoda et al., 2020; Ekasari and Kurnia, 2023). Changes in the tree diameter at breast height can be used to indicate the health status of trees because unusual growth pattern such as sudden decreases in diameter growth and height could be a sign of stress, diseases or environmental factors affecting the trees (Ekasari and Kurnia, 2023). The present study established a moderate positive relationship between height and diameter of trees. This outcome is in concordance to other reports where DBH was used to estimate tree height using allometric models (Hardjana, 2013; Tian et al., 2022). It also agrees with other studies that established positive relationships among tree heights, DBH and crown diameter (Shoda et al., 2020).

On the basis of tree family cover, the riparian ecosystem was the largest. The presence of rapid river flow in riparian ecosystem during rainy season

and stagnant nature of the river in dry season across this ecosystem offer a unique microclimate that is suitable for accumulation of organic matter, growth and regeneration of tree species (Dahlhausen et al., 2016; Abdulkadir et al., 2017). Regardless of the existing results, the riparian zones have been reported as one of the habitats most threatened by anthropogenic activities (Mendez-Toribio et al., 2014). The present outcome agrees with some reports on the resilience and pliability of the riparian ecosystem to maintain biodiversity (Aishan et al 2018; Dybala et al 2019).

The low family cover in the plantation ecosystem may indicate a loss of tree biodiversity possibly due to pressure on trees species for different utilitarian purposes (Chen and Cao, 2014; Dahlhausen et al., 2016). The present outcome agrees with other ecological reports on the reduction or loss of many tree species belonging to different botanical families attributed to deforestation, habitat destruction, habitat fragmentation, climate change and other anthropogenic factors (Onen et al., 2019; Zhou et al. 2021). Families that recorded the lowest frequencies in the riparian (Combretaceae, Anacardiaceae, Aquifoliaceae and Annonaceae) and grazing ecosystem (Sopataceae and Combretaceae) are known to contain important tree species of great ecological benefits. This may imply a state of disruption in ecosystem structure and functions, hence the inability of the various ecosystems to carry out their ecological services (Tilman et al 2014; O'Brien et al, 2017). The observed condition is aggravated in the plantation ecosystem that lacked many ecologically important tree families.

Analysis of the herbs family cover showed the existence of 21 families in the grazing ecosystem followed by the riparian ecosystem with 17 families while the plantation ecosystem had the least. The low family cover in trees and herbs in the plantation ecosystem is a worrisome concern that should be addressed through a comprehensive conservation program and withdrawal of factors causing loss of plant species.as reported in other

studies and conventions (Wang et al., 2013; Zhou et al., 2021; IUCN, 2024). Regardless of the outcome of this study, it has provided a baseline documented inventory of the sizes of trees and family cover of trees and herbs in the tree ecosystems. The dominance of families leguminosiae and poaceae suggests might have been influenced by agricultural production of crops needed by the people basically for food purposes. This is because these families contribute largely to staple food consumed in the study area.

5. CONCLUSION

The present study has reported the dominance of short trees of 6-15m with narrow diameter (51-100cm) while classes above this range were few, an indication of anthropogenic pressure on the tree species. On the basis of tree and herbs family cover, the riparian and grazing ecosystems had larger family covers than plantation ecosystem. The information provided is crucial in the management, conservation and sustainable utilization of documented plant species on the basis of the existing vegetational physiognomy and family in the affected ecosystems.

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