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Structure, Values, and Mortality Factors of Household Forests in Maradi City, Niger

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SUMMARY

Urban houses play a central role in the conservation of woody biodiversity. However, there are not enough studies that have determined the structure of woody plantations in houses, as well as the services provided and the causes of their mortality. This study, conducted in the city of Maradi in Niger, more precisely in the Zaria II district of Commune 2, aims to determine the number of woody species, their values, and the causes of their disappearance. To achieve this objective, socioeconomic and botanical surveys were carried out using a questionnaire administered to 73 heads of households. The results revealed a total of 34 woody species inventoried in the houses, belonging to 21 families and 30 genera. Fabaceae (11%) are the dominant family. These tree species provide four categories of services, including only one cultural service, which is beauty (8.82%), regulatory services: fight against erosion (5.88%) and fight against wind (10.29%). The supply services cited are pharmacopoeia (16.17%), human food (14.70%), firewood (4.41%), shade (17.64%), and finally, support services: CO_2 capture (5.88%) and comfort (13.23%). The indices of floristic diversity show that the Zaria district is rich, with a Shannon index of 2.94 and Piélou equitability of 0.83. We recorded 76.47% of the woody exotic species (26 species) and 23.53% of indigenous woody species (8 species) with strong significance ($P < 0.05$). The equality of expectations test (paired observation) carried out on the number of species and the socio-demographic characteristics (sex, marital status, number of women, number of children, mode of acquisition) reveals that there is a significant relationship between the number of species and these characteristics ($P < 0.05$). However, the test on the number of species and mode of acquisition shows that there is no relationship between them ($P > 0.05$). This study will lead to a better understanding of the place of woody species in houses. The findings of this study can be applied toward the local and global efforts to conserve tree biodiversity in dryland cities in way that the tree biodiversity will provide a variety of ecosystem services to the urbanites for green and sustainable cities. The study recommends also the massive use of native tree biodiversity in tree planting initiative in the houses for sustainable biodiversity conservation.

Key words: Urban, Trees, Forests, Ecosystem

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INTRODUCTION

Urban and peri-urban forests offer essential regulating, cultural, and provisioning services on both local and global scales (Borelli et al., 2023). These urban forests deliver significant environmental, social, and economic benefits to city residents (Nowak and Dwyer, 2007). Forest resources play a variety of role in agro-sylvo production systems in Africa. For instance, the timber forests products are great source for the rural communities' livelihood. The wood forest products serve are source of food and medicinal products for humans and animals. Its exploitation is an income generating activities for many households (Diatta, 2019). In Niger, they offer a variety of services such as socio-economic and ecological. They are also means of combating soil erosion and climate change manifestation. However, the anthropogenic pressures on the wood forest products constitute a menace to their sustainability (Adamou et al., 2021).

Today, the urban areas physical expansions is one of the environmental issues as the city and its surroundings are losing their vegetation cover as they modernize. This study is part of a context of environmental degradation, particularly of vegetation cover in urban areas (Manna et al., 2025). However, the urban forests of rapidly urbanizing cities in Niger particularly that of Maradi, have been the subject of few studies. Their woody floristic diversity and structure are not well known (Souley et al., 2025). Trees are an essential component of the urban ecosystem. Urban green spaces contribute to the quality of the living environment and the attractiveness of cities. They address not only social and ecological issues but also economic ones. Many benefits are associated with the presence of trees in homes. Among these benefits are reductions in atmospheric pollutants, heat islands, carbon dioxide levels through the phenomenon of carbon sequestration, and erosion control (Piracha and Chaudhary, 2022; Addas, 2023a, b).

Urban trees respond also to the socio-economic and ecological problems as they provide a myriad of ecosystem services such as food, energy, and medicines. Tree species occupy a great place in African communities as they are part of socio-cultural processes. Despite this great importance, urban trees are destroyed due to the building activities in the cities. This raises the question about the role of tree species in residential areas generally and specifically in the houses. Some studies have made a particular object of study and addressed in various published literature. This literature can be grouped in three major axes such as botany, functions, and, more recently the relationship with urban people life (Roba, 2025; Schindler and Schindler, 2025).

Few studies have been conducted in order to characterize the structure, values and factors of diversity and mortality of household forests. There is mostly a scarcity of studies in that regards especially in West Africa Sahel cities where the residential areas are zone constructing socio-economic and ecological development. Thus, this study tries to close the aforementioned regional research gap by determining the floristic composition of tree plantations in the houses of the Zaria II district; assessing the ecosystem services provided by perennial species in these homes; identifying the factors contributing to tree mortality in the area; and exploring the factors influencing species diversity in residential settings.

MATERIALS AND METHODS

STUDY AREA

The study was conducted in the Zaria II quarter which covers an area of 1085 hectares (ha) in the district 2 of the city of Maradi. The Zaria II quarter is located between 13°50' North and 7°12' East as shown in the figure 1. It is in the Sahel agro-ecological zone with mean annual rainfall varies between 150 mm and 350 mm (National Council for the Environment for Sustainable Development, 2016). Maradi is positioned at latitude 13°29' N and longitude 7°05' - 7°09' E in south-central Niger. Maradi is the economic capital of Niger and covers an area of 86 km² (Issoufou et al., 2020).

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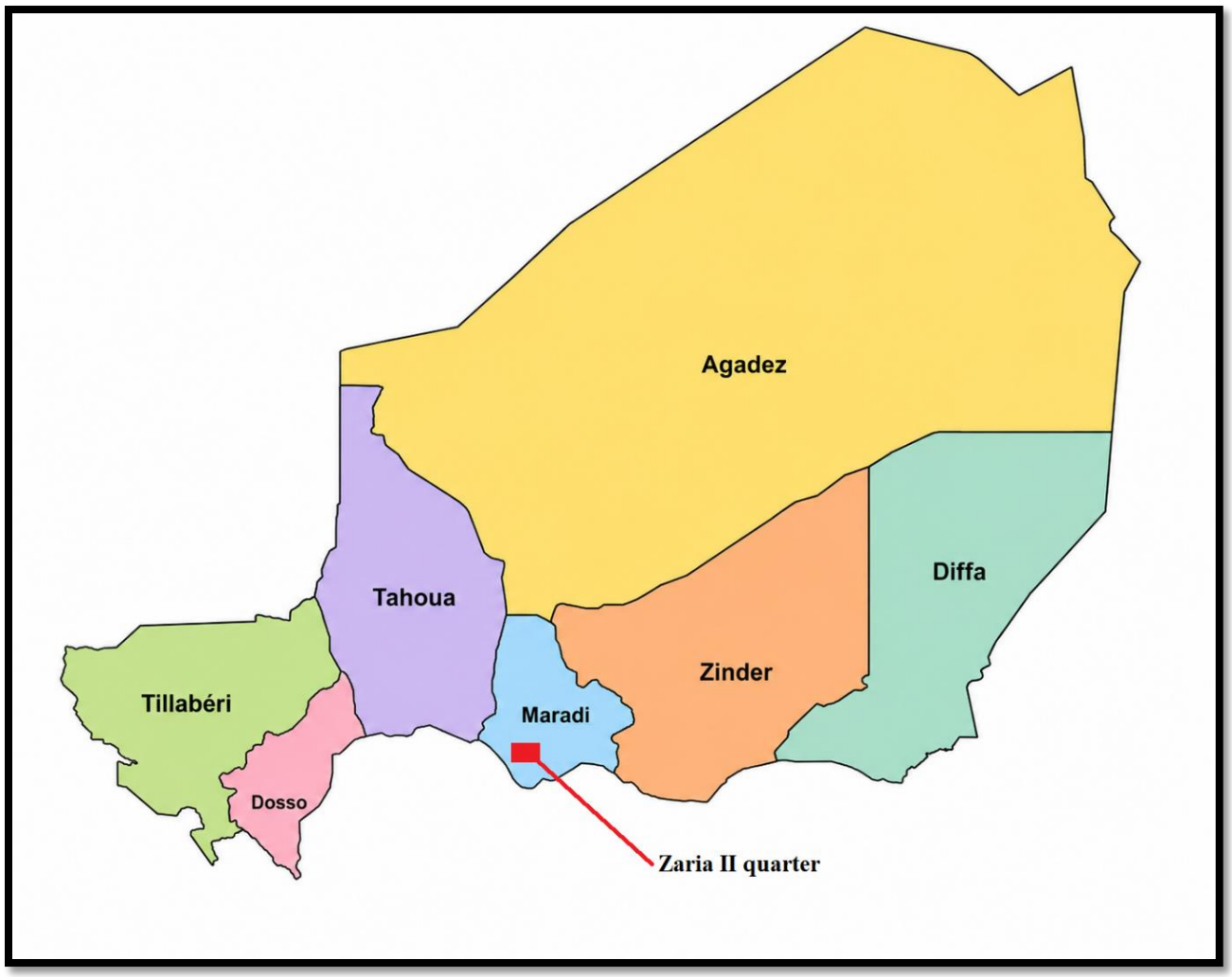

Figure 1: Location map of Household Forests in Maradi City, Niger.

Data collection

Data collection was conducted through surveys in city of Maradi. A semi-directive questionnaire was administered to all participants in each household. Selecting the head of household as the sampling unit was justified by their ability to provide crucial information on woody diversity, ecosystem goods and services, species availability,

the causes of scarcity, and recommended management and conservation methods. The total number of households in the neighborhood was obtained from the homeowners.

$$n = \frac{Z^2 p(1-p)}{E^2}$$

While
n is the size of the sample required,
Z is the score of the test statistic corresponding to the desired confidence level (for example, for a confidence level of 95).
p is the estimated proportion in the population (5% in our case, so p = 0.05),
E is the desired margin of error (expressed in decimals).
If we take a margin of error of 5% (E = 0.05), and a confidence level of 95% (Z = 1.96), we can calculate the sample size as follows:

$$n = 1.96^2 \times 0.05 \times (1-0.05) / 0.05^2$$
$$n = 3.8416 \times 0.05 \times 0.95 / 0.0025$$
$$n = 0.18258 / 0.0025$$
$$n \approx 73$$

So, for a proportion of 5% in the population and a margin of error of 5. Once the sample is known, the heads of households are surveyed according to their availability until the required number of people to be interviewed is reached.

The surveys were supplemented by field observations with the aim of finding the species that were cited by their local names, "Hausa or French," and identifying them through their scientific names. For species that could not be identified on-site, photos and leaf samples were taken to facilitate identification in the documentation. Thus, a number of applications (Google Search image and Google Photos) from biology and botanical specialists were used.

RESULTS

WOODY FLORISTIC COMPOSITION

The floristic inventory of the woody plantations in the Zarria II district allowed us to identify 34 species divided into 31 genera and 21 families, including 8 local species (24%) and 26 exotic species (76%). We recorded 76.47% of the woody exotic species (26 species) and 23.53% of indigenous woody species (8 species) as indicated in table 1.

Table 1: Floristic compositions of woody species in the Zarria II district

Sites	Species	Genera	Family	Exotic species	Indigenous species
2	34	31	22	26	8

Frequency analysis of woody species in the Zarria II district

The frequency analysis (Figure 2) made it possible to determine the frequency of species in the Zarria II district of the city of Maradi. It showed that the species *Moringa oleifera* is the most frequent in the district with a presence frequency of 20%. It is followed by the species *Azadirachta indica* (12%), *Mangifera indica* (8%),

and *Clerodendrum inerme* (7%). The species *Citrus limon*, *Polyalthia longifolia*, and *Syzygium guineense* each have a frequency of 6%, while *Phoenix dactylifera* has a frequency of 4%, and *Combretum indicum* has a frequency of 3%. Species such as *Annona senegalensis*, *Psidium guajava*, *Terminalia catappa*, *Terminalia mantaly*, *Carica papaya*, *Vernonia amygdalina*, *Manihot esculenta*, *Bougainvillea glabra*, and *Dodonaea viscosa* each have a frequency of 2%. Species such as *Moringa stenopetala*, *Musa acuminata*, *Gossypium hirsutum*, *Ficus benjamina*, *Ficus platyphylla*, *Tamarindus indica*, *Senna* siamea, *Blighia sapida*, *Balanites aegyptiaca*, *Calotropis procera*, *Anacardium occidentale*, *Eucalyptus camaldulensis*, and *Ziziphus mauritiana* have a low frequency of 1%, while *Piliostigma reticulatum*, *Lannea microcarpa*, and *Ziziphus mucronata* are infrequent in the neighborhood.

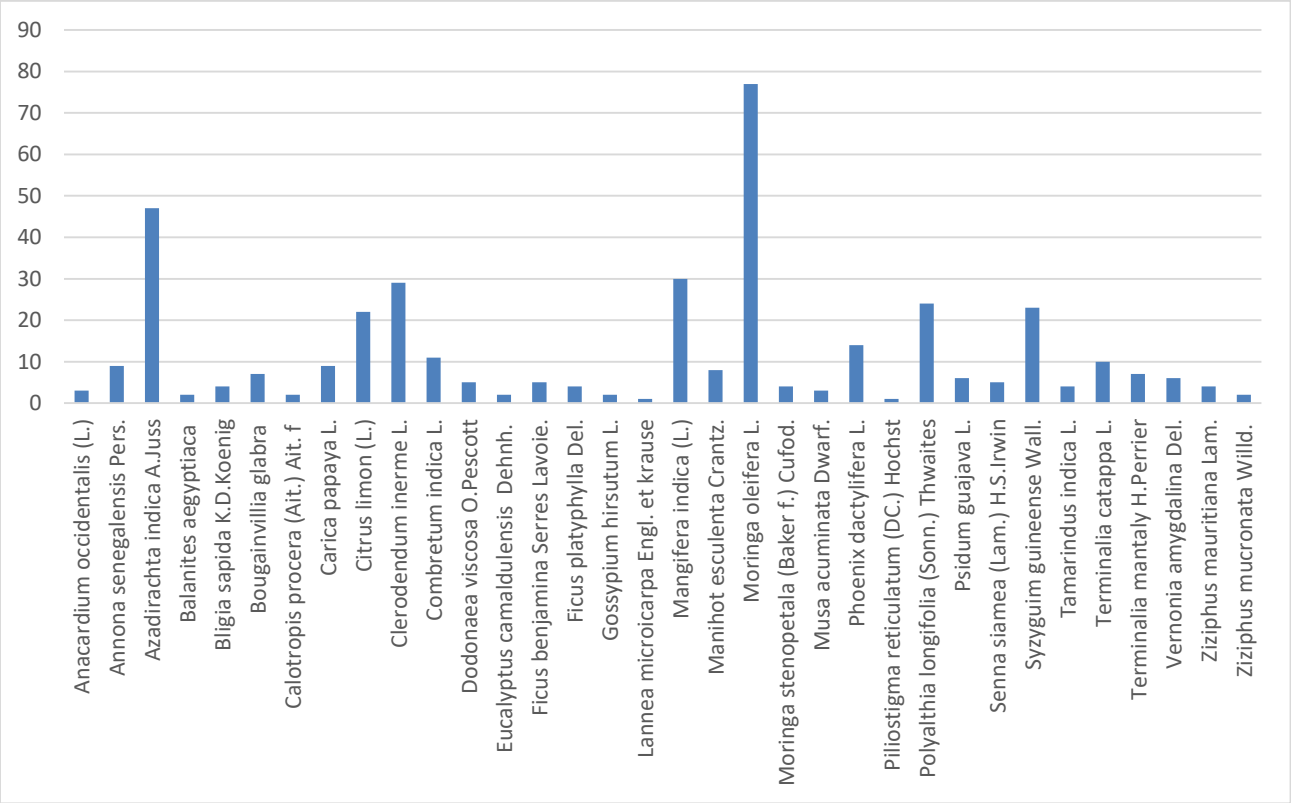

Figure 2: Frequency of different woody species

Proportion of species recorded by family

The analysis of proportions made it possible to determine the percentage of families of their species in the Zarria II district of the city of Maradi. In the district, the most represented family is that of Fabaceae (11%). Anacardiaceae, Combretaceae, and Myrtaceae each account for (8%). Annonaceae, Moraceae, and Moringaceae each have (5%), while Arecaceae, Asclepiadaceae, Asteraceae, Caricaceae, Euphorbiaceae, Liliaceae, Malvaceae, Meliaceae, Musaceae, Nyctaginaceae, Rutaceae, Verbenaceae, and Zygophyllaceae each account for (3%) in the district. Table 2 shows the distribution of diversity indices, the Shannon index was 2.94 and a Piélou index of 0.83.

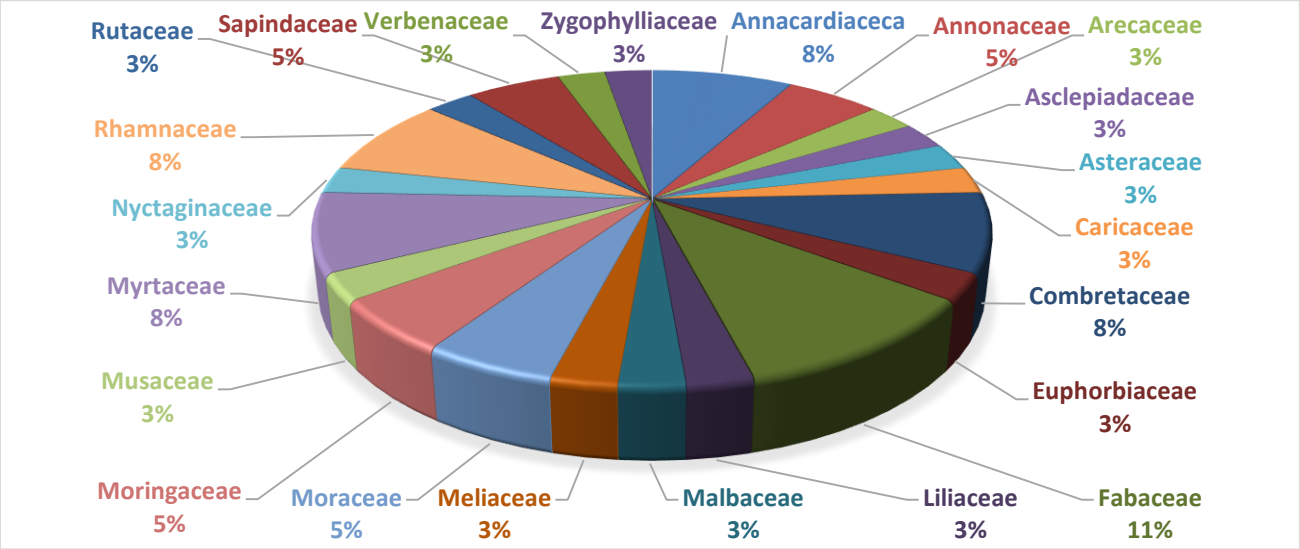

Figure 2: Distribution of species by family

Table 2: Diversity indices.

Diversity Indices	Symbol	Value
Shannon index	H'	2.94
Piélou index	E	0.83

Factors affecting long-term mortality of residential urban forests

The factors contributing to the mortality of woody species in the Zarria II district, as reported by the local populations during our survey, are summarized in Figure 3. The results indicate that wind is the leading cause of mortality at 24%, followed by lack of maintenance (16%), rain and bacterial diseases (both at 16%), wastewater (12%), construction activities (8%), and finally, heat and bark stripping, each at 4%.

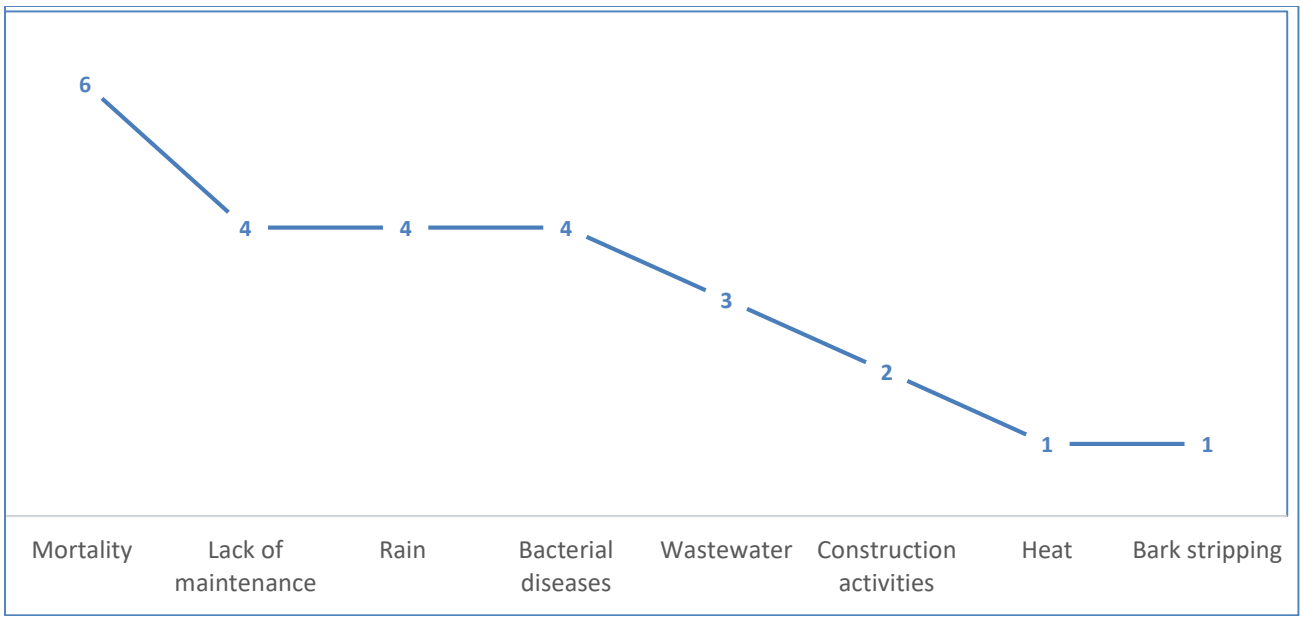

Figure 3: Factors of tree species mortality.

The importance of woody plants

From Figure 4, we note that shade (17.64%), pharmacopoeia (16.17%), food (14.70%), comfort (13.23%), wind protection (10.29%), beauty (8.82%), CO2 capture (5.88%), erosion control (5.88%), and finally firewood (4.41%) remain the most cited by the individuals surveyed.

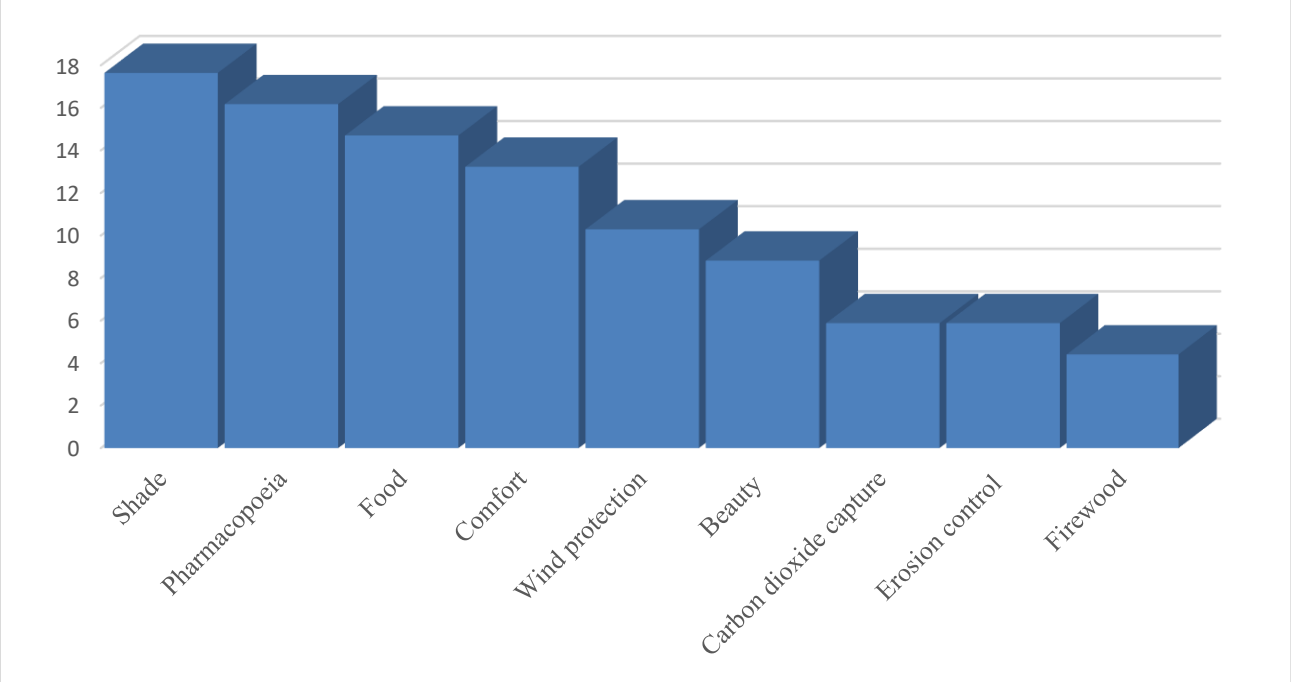

Figure 4: Importance of woody plants in the household forests

DISCUSSION

The results obtained from the study carried out on the woody floristic composition of the Zarria II district, commune 2 of the city of Maradi, reveal a specific richness of 34 woody species divided into 31 genera belonging to 22 families, with Fabaceae as the dominant family. This floristic composition found is lower than that obtained (Diedhiou et al., 2014). The latter found, following the inventories carried out in the commune of Saré Yorobana located in the Kolda region, 77 species belonging to 67 genera and 25 families. Fabaceae was the dominant botanical family in the study area which confirms the results of (Moussa, 2019) who reported the predominance of legume trees specie in the agroforestry system in Niger. Such result can also be explained by the capacity of legume tree species to live in the difficult environmental conditions (Sreetheran et al., 2011). Added to that, this dominance could be due to the tree species recorded in family are multipurpose tree species. Our study reported that there were more exotic tree species than indigenous tree species in the household forests in the Zaria II. This may explain the diversity of urban forest may be due to the choice of the urban people to plant in their houses. The low percentage of indigenous tree species in the district can be explained by the fact that few local species are planted which may be due to the availability of sapling materials. This dominance could be due to urbanization which is a major cause of a major cause of biotic homogenization (McKinney, 2006).

The alpha biodiversity indices calculated in the urban household forests in Maradi city reveals high values such as tree species richness (34 perennial species), Shannon index (2.94) and evenness (0.83). This indicates the role of urban household forests in tree biodiversity conservation which has to be accounted in the city biodiversity conservation plan. Our results corroborate the findings of researchers (Moussa, 2019), who reported similar alpha biodiversity indices values of 2.48 and 2.30 while studying the floristic composition and structure of urban forests in the cities of Niamey and Maradi. This high values of the recorded alpha biodiversity indices may be to the use massive use of exotic tree species in the household forests such as multipurpose exotic tree species: *Blighia sapida*, *Citrus limon*, *Moringa oleifera*, *Mangifera indica*, *Syzygium guineensis*, *Lannea microcarpa*, and *Terminalia catappa.* Concerning the high evenness (0.83) recorded in this study signifies that the household forest in Zaria II constitute a well-balanced community where the tree species abundances are well distributed. It also indicates that all tree species recorded in this study have similar distribution. The high values of alpha biodiversity recorded in this study is an indication of botanical diversity as highlighted (Yahara et al., 2013), which is central to meeting the sustainability of household's areas. This as previous ethnobotanical studies have highlighted the significance of woody vegetation for the well-being of surrounding communities in arid and semi-arid regions of Africa (Ndiaye et al., 2023). Woody species contribute both wood and non-wood products to these populations (Hama et al., 2019).

Apart from food and shade, respondents cite pharmacopoeia, comfort, wind protection, and beauty. Respondents also cited CO_2 capture, erosion control, and firewood. The CO_2 capture is key to the national effort of reducing the green houses gases emissions in but it has been citer rarely by the urbanite respondents which could be due to the methods used to collect the data as this been reported to affect the collected information (Tourey et al., 2021). This could lead to the belief that the populations surveyed are unaware of this role. The same observation was made by Aya-ay and Badong (2026), who highlighted this important ecosystem service through the evaluation of the rate of CO_2 sequestered from plantations in the towns of Dapaong. As for the role of CO_2 capture, it appears that the populations attach little importance to it. The main uses of woody plants are numerous, including food needs (14.70%), pharmacopoeia (16.17%), shade (17.64%), firewood (4.41%), comfort (13.23%), erosion control (5.88%), and wind protection (10.29%). For food needs, several fruit species, notably *Mangifera indica*, are the most requested and contribute to ensuring the nutritional balance of populations. *Moringa oleifera* is the most cited species in the pharmacopoeia, while *Azadirachta indica* and *Citrus limon* are also sought for medicinal reasons (Tourey et al., 2023). Thus, supply services (with 53.81% of citations) are considered more important than regulation services (16.17%) according to the populations. This indicates the level of dependence of rural populations on woody plant resources for the supply of woody and non-woody forest products to improve their living conditions (Ndiaye et al., 2023).

Forest resources are of great significance for the populations even though they are under great threat from natural and human factors such as climate change impacts (Ngom et al., 2013). Concerning tree species mortality as reported in our study, which indicates that in the household forests in the district of Zaria II, the factors of tree

mortality are climate (heat, strong winds, and rainfall), lack of tree maintenance, household wastewater, construction, and bark stripping. Conducted statistical analysis reveals a significant relationship ($P < 0.05$) between species diversity and socio-economic characteristics (sex, marital status, number of women, number of children, and mode of acquisition).

Fan et al. (2019) who reported that socio-economic variables of the urban tree owners determine the urban forest structure and diversity. But there is no significant relationship between the number of species and the household landmass areas ($P > 0.05$) at the 5% significance level. This contradicts the fact that the larger is the areas or smaller does not have effects on the number of tree species. This may be due to the fragmented urban areas such as build areas like household areas the number of tree species may be high in the small land areas due to the human intervention such as planting more tree species for more services. It may be also due to in the large household areas; small areas are used for tree planting.

CONCLUSION

Our study constitutes an attempt of assessing the tree floristic composition of a household forest which is a type of urban forests, forgotten in the urban forestry literature. This study reported that household forests is an urban forestry type which is rich in tree species with predominance of exotic tree species. Information about the household forest through this work will help in the managing and planning for future urban forestry projects in household areas which should propose the massive use of indigenous tree species for sustainable urban biodiversity conservation in residential areas. This study highlights household forests as potential type of urban forests for biodiversity conservation and ecosystem provision for the betterment of the urban household people. This study recommends further studies that will look the structure and ecosystem services of the household forests across the different quarters in urban areas.

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