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Initial analysis of urban forestry in Mbour Municipality, Senegal

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ABSTRACT

Diversification of urban flora is undertaken by several municipalities in different forms around the world. This global effort also concerns senegalese municipalities and must be assessed. The objective of the work is to evaluate urban forestry in the municipality of Mbour. To do this, a floristic inventory was carried out at the level of target quarters, wooded areas, roads and technical services and data were analyzed. Results showed that concessions and wooded areas are richer than technical services and main roads. Seventy-seven plant species from concessions and wooded areas representing 37 families were identified and listed particularly in the Mimosaceae family. Along the various roads in the urban transport network, 1075 trees representing 16 species and 11 families have been registered mainly among Meliaceae. Technical services included 42 species and 295 trees: 21 species and 53 individuals in forest service, 17 and 99 in rural development divisional service (SDDR), 12 and 42 for urban service, 11 and 71 for municipality, 5 and 30 in the prefecture. Trees are present in Mbour town. Regular monitoring will allow their spatio-temporal dynamics and make necessary improvements.

Keywords: Urban forestry, floristic composition, trees, perception, Mbour, Senegal.

INTRODUCTION

The importance of urban trees no longer needs to be demonstrated (Nilsson and Randrup, 1996; Kuchelmeister, 2000). Trees are an essential element of urban infrastructure for a livable and sustainable environment. Urban forestry is a modern approach to tree management in cities that covers both long-term planning, implementation and management and forest stands with amenity values, located in urban areas or nearby (Nilsson and Randrup, 1996).

Population growth and environmental degradation, particularly natural resources, are closely linked phenomena. In the year 2000, more than half of the planet inhabitants live in cities; It is in the developing world that the acceleration of urbanization is most spectacular: the number of city dwellers there has more than quadrupled since 1950. Two-

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thirds of the population growth of developing countries is absorbed by cities. This unprecedented acceleration of urban development has considerably affected man's relationship with trees and forests (Ngarmari, 2012).

In Africa, there is a growing awareness of the necessity for forests and peri-urban parks to meet physical, material and recreation needs. These needs evolve due to African urbanization which, from 18 to 21% between 1950 and 1970, jumped to 32% in 1984 (Sène, 2000). In most cases in Africa, management and development of cities are beyond the control of decision-makers, which has worrying repercussions on the ecological and sociological levels.

In Senegal, a Sahelian country, since the early 1900s, Dakar, a pioneer of Sahelian cities, has a series of master plans to govern interface between urban and undeveloped land in order to cope with high demographic pressure. Their implementation has been at the best only partial, given rapid rise of slums, unauthorized construction and recourse to already done, which have left little room for the development of green spaces.

The problem of urban forestry in Senegal is closely linked to the management of existing natural resources and the lack of growth of wooded areas in cities. Indeed, a degradation of urban wooded areas by unsustainable exploitation of natural resources (wood, fodder, etc.) is due to a rapid increase in urban population, often uncontrolled. In addition, there is strong pressure on land for extension of built-up areas and infrastructure.

This experience of Dakar should serve the younger and even less populated interior cities. A reference situation is necessary for a good understanding of current dynamics, especially in decentralization context. The objective of this work was to establish the inventory of urban biodiversity to facilitate monitoring of urban forestry in Mbour municipality.

MATERIALS AND METHODS

Study Site

Mbour municipality (Figure 1) is located along the Atlantic Ocean, on the small coast, south of the Thiès Division and 83 km from Dakar, between 14°24'42"North and 16°57'57" West. It is borderd to the west by the Atlantic Ocean and to the north by the Saly municipality. It is surrounded on the other sides by Malicounda municipality. It is the capital of the division of the same name which is located 73 km south of Thiès town. After several expansion waves, it has extended over an area of 2788 ha since 2000 (Mbour Municipality, 2017).

Average temperatures vary between 20°C and 35°C and the annual average is around 26°C minimum temperatures can go up to 16°C between January and February and the maximum can rise to 35°C between March and October. Average insolation varies between 8 and 9 hours per day. It is a tropical climate which is characterized by alternating of a dry season (9 months) and a rainy season (3 months). Rainfall amounts vary between 400 and 600 mm. With ocean proximity, the average relative humidity of the air is 70% (Municipal development plan, 2017).

Mbour Division is relatively flat with the presence of the Diass massifs which rise to an altitude of 90 m. Four major types of soil cover the divisional area. These are: tropical ferruginous soils, brown and red-brown soils, lateritic outcrops and clay soils (Mbour Forest Sector, 2019).

Water resources are contained in the Continental Terminal or Eocene water tables, with the sedimentation of the basin formed by the Secondary and Tertiary geological formations. Thus, significant water reserves have been formed in the areas of Diass massif, thanks to the constitution by Paleocene limestone of an aquifer in the area. It is drinking water that the municipality will be able to use for its supply (Municipal development plan, 2017).

Mbour divison has various vegetation facies types. There is a stratum treed or tree savannah (*Faidherbia albida*, *Acacia raddiana*, *Acacia senegal*, *Balanites aegyptica*, etc.), a shrubby stratum or shrub savannah (*Guiera senegalensis*, *Combretum sp*., etc.) and a herbaceous stratum or herbaceous savannah (*Zornia glochidiata*, *Cenchrus biflorus*, *Andropogon gayanus*, *Schoenefeldia gracilis*, etc. (Mbour forest sector, 2019).

Population of Mbour municipality is estimated at 252,645 inhabitants in 2016 (Figure 2). It is made up of 125,012 women (49.48%), reflecting a slight numerical advantage for men. It is a population characterized by its youth, 75.97% of the population are under 35 years old. Population is made up of Wolofs, Serer, Pulaar, Mandingos, etc.

Demographic growth of the city has experienced a very rapid and regular evolution which is explained by a high average rate of natural increase, but also by migration waves linked to economic dynamism of the Mbour tourist and seaside agglomeration.

Methods

Quarters Choice

Approach for inventory sample choice is as follows: Mbour Commune being made up of 27 quarters, half have been inventoried, that is to say 13 quarters, i.e. a sampling rate by 50%.

Stratified inventory was based on the quarters' degree of vegetation cover. Thus, choice of districts followed this principle which includes most and least covered districts. From Google Earth, it appears that the central districts are the densest in vegetation and the peripheral ones the least dense. Also, 13 quarters have been distributed as follows: 7 in more covered area and 6 in less covered area.

Choice of road axis

In Mbour municipality, road network is made up of main road axis (Route National Road 1 (RN1)) and secondary roads (Table 1). For its inventory, all roads dimensioned with Google Maps have been listed. Total distance is 28 km. Fisher formula was used, with an accuracy of 20%, to calculate survey rate which is 47.16%. This made it possible to estimate distances to be covered by road. The total is 13.2 km (Table 1).

Choice of wooded areas

For the choice of wooded areas, map (Figure 1) of the municipal development plan Mbour commune was used. It shows 12 wooded areas. Half have been inventoried, that is to say 6 wooded areas including a botanical conservatory, green space of Serigne Saliou Mosque and 4 green areas. Quantitative analysis of vegetation structure was carried out using the method of Caratini (1985) according to Table 2.

Data collection and use

To take stock of forest resource in the city, traveling survey method (Kouadio et al., 2015) was used to collect floristic data. It consisted in noting all species encountered during course of various main roads. To this end, all trees planted in alignment around various roads have been identified. At the level of wooded areas, it was first carried out a direct observation, to assess presence of trees and subsequently, counting of trees was carried out, due to the low density.

Data collected was compiled in Excel. Maps were produced using Arcgis software. All results have been extrapolated to municipality scale.

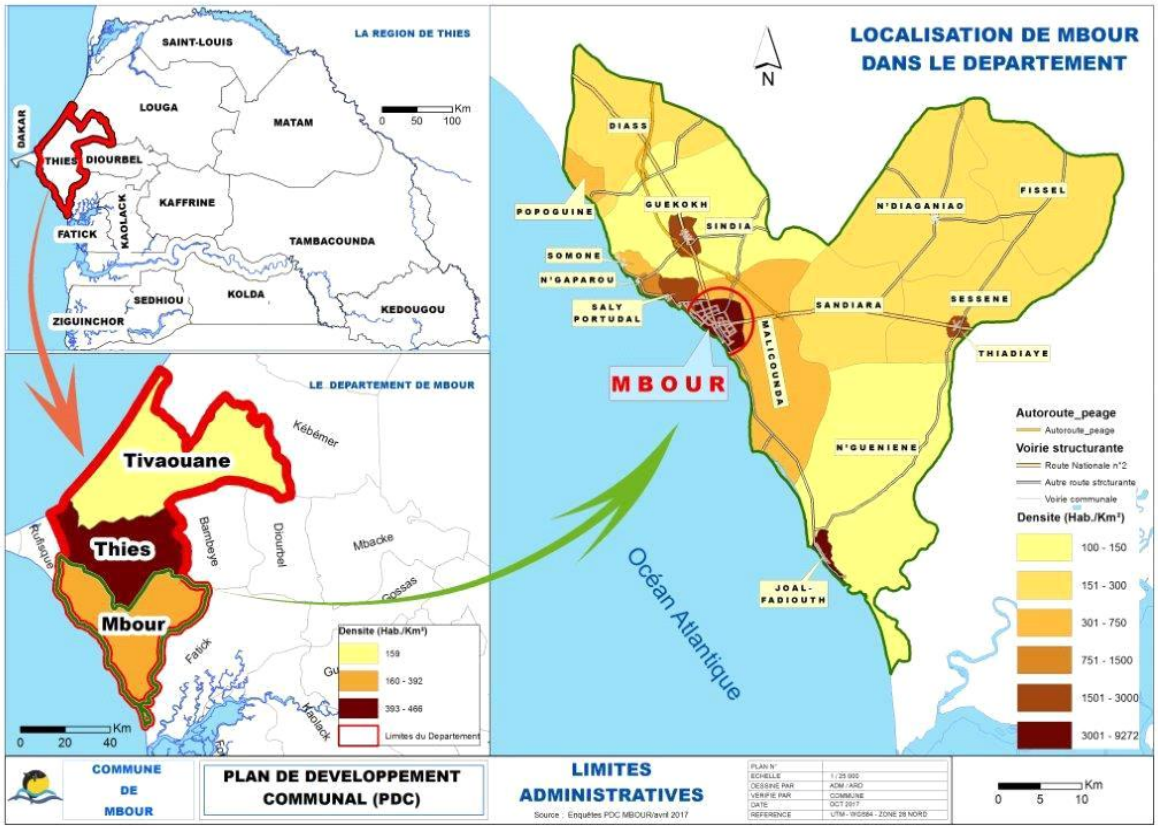

Figure 1: Location and administrative organization of the Mbour Municipality.

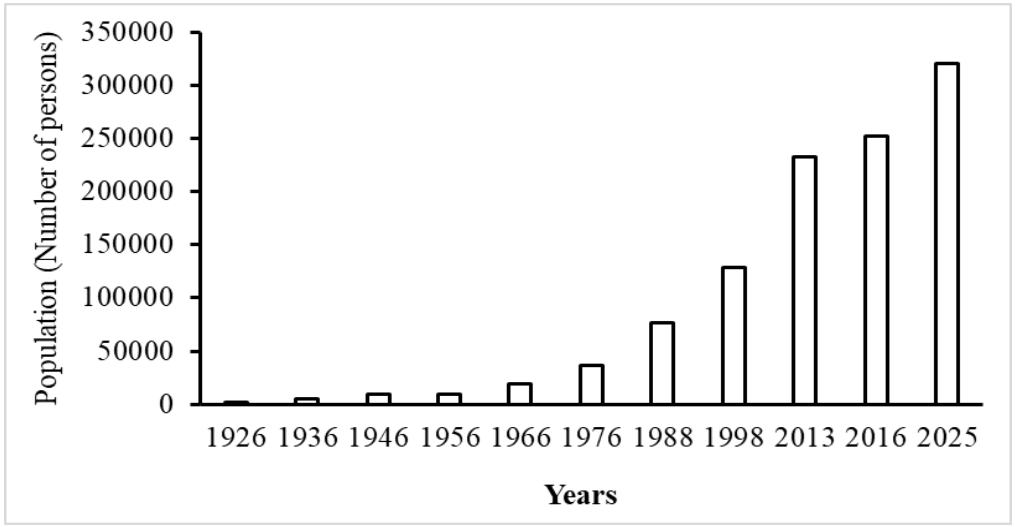

Figure 2: Ten-year evolution of the population from 1926 to 2025 (SRSR de Thiès, 2016).

Table 1: Road axis and distance to be inventoried.

Road axis	Distance (km)	Distance to be inventoried (km)
National road 1 (RN1)	5,5	2,5938
Saly carrefour-Grand Mbour	2,0	0,9432
Saly- Lycée Demba Diop-Marchée	5,0	2,358
Stadium-Grand Mbour	1,3	0,61308
Stadium-Liberty	3,3	1,55628
Lycée Demba diop-RN1	1,0	0,4716
RN1-Rail	1,7	0,80172
Lycée Demba Diop-route de Joal	1,1	0,4716
Joal road	4,1	1,93356
City hall-Santessou	1,8	0,84888
Market-Thiocé-RN1	1,2	0,56592
Total	28,0	13,2048

Table 2: Correspondence table of frequency indices and their qualifications.

Frequency	Indice	Qualification
0.8 à 1	V	Constant
0.6 à 0.8	IV	Abundant
0.4 à 0.6	III	Frequent
0.2 à 0.4	II	Accessory
0 à 0.2	I	Rare or accidental

RESULTS

Floristic inventory in concessions and green spaces of Mbour municipality

Global flora analysis in concessions and green spaces

The global flora examination in concessions and green spaces of Mbour municipality reveals the presence of 38 families, 77 species including 39 exotic and 38 indigenous, mainly forest and woody except 4 (*Boerhavia diffusa auc*t.; *Cymbopogon citratus* (DC.) Stapf; *Tradescantia zebrina* (Heynh. ex. Bosse); *Vetiveria nigritana* (Benth.) Stapf) (Table 3). The total number of individuals counted is 2973.

Analysis of specific and flora importance of quarters and wooded areas of Mbour municipality

The Mimosaceae family is the most represented with 27.72% of species. It is followed by Apocynaceae 25.13%, Meliaceae 12.34%, Araceae 7.06, Combretaceae 3.13% and the other families (Zygophyllaceae, Moringaceae, Myrtaceae, Moraceae,

Rhamnaceae, Rutaceae, Caesalpiniaceae, etc.) represent 24.62% (Table 4). A total of 2,973 individuals were counted in neighborhoods and wooded areas. The dominant species are, in order of importance, *Prosopis juliflora* (sw) DC. with 762 feet or 25.63%, *Calotropis procera* (Aiton) W.T.Aiton 678 feet or 22.81%, *Azadirachta indica* A. Juss. 243 feet or 8.17%, *Cocos nucefera* L. 187 feet or 6.29%, *Mangifera indica* L. 124 feet or 4.17% and the other species share 979 feet or 32.93% (Table 4).

Forest species are the most planted with a proportion of 74.97%, followed by fruit species 17.63% and forest fruit species 7.40%.

Species consistency in quarters and green spaces in Mbour municipality

The species present in Mbour municipality are distributed in different quarters and wooded areas with a certain frequency. Table 5 presents the proportion of the number of species according to the Caratini index (1985).

More than two thirds of the species (70.13%) identified are rare or accidental (Table 5). Accessory species represent 18.18%. We can cite *Adansonia digitata* L., *Terminalia mantaly* H. Perrier, *Calotropis procera* (Aiton) W.T. *Aiton, Hura crepitans* L., *Balanites aegyptiaca* (L.) *Delile, Cassia siamea* (Lam.) H.S.) A.Chev. , *Leptadenia hastata* (Pers.) Decne., *Prunus cerasus* L., *Carica papaya* L., *Annona muricata* L., *Cocos nucefera* L., *Citrus sinensis* (L.) Osbeck, *Musa sinensis* L. We note a proportion of 9.09 % at the level of frequent species (*Gmelina arborea* Roxb, *Azadirachta indica* A. Juss., *Cordia sebestena* L., *Delonix regia* (Bojer ex Hook.) Raf., *Moringa oleifera* Lam., *Ziziphus mauritiana* Lam., *Citrus limon* (L.) Burm.f.), at the level of abundant species with 2 species (*Ficus sp* L., *Mangifera indica* L.). Constant species are not listed in Mbour municipality.

Inventory of roads in Mbour municipality

Floristic richness of linear plantations

Road axis inventory has taken place on the entire urban transport network of Mbour municipality. Table 6 shows the distribution of species to families. Meliaceae family is the most represented with 48.28% of species followed by Moraceae 15.63%, Boraginaceae 10.42%, Euphorbiaceae 8%, Caesalpiniaceae 6.98%, Verbenaceae 4.74%. Other families contain 6% of species.

The 1075 feet counted during road inventory are divided into 16 species belonging to 11 families.

Average density corresponding to the number of individuals counted over the distance sampled and reduced to a distance of one meter, is 0.081 $ft.m^{-1}$, i.e. less than 2 trees every 20 m. As shown in Table 6, *Azadirachta indica* A. juss is at the top of the ranking followed by *Cordia sebestena* L. and *Ficus sp* L. almost 4 times less present, then in smaller and smaller proportions by *Khaya senegalensis* (Desr) A. Juss., *Hura crepitans* L., *Ficus thonningii* Blume, *Delonix regia* (Bojer ex Hook.) Raf, *Gmelina arborea* Roxb., etc.

Species presence in road axis

Figure 3 represents specific diversity at the level of Mbour municipality roads in 2020.The RN1 and the road from Stade to Liberté are the richest axis with 12 species followed by Joal road with 11 species, Saly-Lycée Demba Diop-Marché road and the Grand Mbour-Saly axis with 10 species, Stade-Grand Mbour (9 species). RN1-Lycée Demba Diop and RN1-Rail with 8 species. Lycée Demba Diop-route de Joal (7 species) and Marché-Thiocé-RN1 (6 species). Among these species, 3 are common to the 11 municipality roads (*Azadirachta indica* A. Juss., *Delonix regia* (Bojer ex Hook.) Raf. and *Ficus* sp L.). The Stade-Liberté road axis includes two species (*Calotropis procera* (Aiton) W.T. Aiton. and *Moringa oleifera* Lam.) and the Lycée Demba Diop (LDD)-Joal road axis with a single species *Mangifera indica* L.

Inventory of state services

Species and number in technical services

Figure 4 represents 42 species diversity from technical services of Mbour municipality

in 2020. Forest service is the richest one with 21 species followed by divisional rural development service (SDDR) with 17 species, urbanism service with 12 species, municipality with 11 species and finally prefecture with 5 species. Among these species, none is common to all 5 services, two are common to 4 services (*Azadirachta indica* A. Juss and *Cocos nucifera* L.), 4 species are common to 3 services (*Mangifera indica* L., *Moringa oleifera* Lam., *Terminalia mantaly* H. Perrier and *Cassia siamea* (Lam.) H.S.Irwin and Barneby), 7 are common to 2 services (*Albizia lebbeck* (L.) Benth., *Anacardium occidental* L., *Annona muricata* L., *Gmelina arborea* Roxb., *Nerium oleander* L., *Faidherbia albida* (Delile) A.Chev., and *Leucaena leucocephala* (Lam.) de Wit.), and 28 species are exclusive to technical services. Urbanism presents 5 exclusive species, municipality 4 species and 9 different exclusive species to forest service and SDDR (Figure 4). The most represented species in technical services are *Azadirachta indica* with 44 individuals, *Casuarina equisetifolia* with 40 individuals, *Nerium oleander* with 30 individuals and *Cocos nucifera* occupies with 18 individuals (Figure 4).

Tree numbers in technical services

Figure 5 highlights the number of individuals for each structure. The Divisional rural Development Service (SDDR) is the most dominant, followed by the forestry service, town planning, the town hall and finally the prefecture.

Global distribution of woody species in Mbour commune

Mbour Commune globally has 88 woody species. Indeed, 28% or 25 of these species are found in wooded areas (WA), 14% in concessions (C) or 12 species and 11% or 10 species in technical services (TS). Eight (8) % or 7 species of these species are found simultaneously in the TS, WA, RA (roads axis) and C, 15% or 13 species in the TS, WA and C, 1% or 1 species in the WA, RA and C, 1% or 1 species in TS, RA and C, 7% or 6 species in WA and C, 7% or 6 species in TS and WA, 3.41% or 3 species in TS and RA, 1% or 1 species in RA and C and finally 3.41% or 3 species in TS and C (Figure 6).

Table 3: Diversity and specific importance of flora in concessions and green spaces of Mbour municipality.

Family	Genus and species	Categories	Origin	Number	Biological type
Anacardiaceae	*Anacardium occidentale* L.	E. fruits forestry	E	16	L
Annonaceae	*Annona muricata* L.	fruit species	E	16	L
	Annona squamosa L.	fruit species	E	7	L
Apocynaceae	*Calotropis procera* (Aiton) W.T.Aiton	E. forestry	I	678	L
	Leptadenia hastata (Pers.) Decne.	E. forestry	I	64	L
	Nerium oleander L.	E. forestry	E	3	L
	Saba senegalensis (A.DC.) Pichon	E. fruit species	I	2	L
Araceae	*Cocos nucefera* L.	E. fruit species	I	187	L

	Borassus aethiopum Mart.	E. fruit species	I	21	L
	Alocasia macrorrhiza (L.) G.Don	E. forestry	E	2	L
Bignoniaceae	*Kigelia pinnata G.Bentham* (Jacq.) DC.	E. forestry	I	1	L
Bombacaceae	*Adansonia digitata* L.	E. fruit forestry	I	29	L
Boraginaceae	*Cordia sebestena* L.	E. forestry	E	22	L
Burseraceae	*Commiphora africana* (A. Rich.) Engl.	E. forestry	I	8	L
Caesalpiniaceae	*Delonix regia* (Bojer ex Hook.) Raf.	E. forestry	E	20	L
	Peltophorum ferrugineum (Decne.) Benth.	E. forestry	E	11	L
	Cassia siamea (Lam.) H.S.Irwin et Barneby	E. forestry	E	6	L
	Tamarindus indica L.	E. fruit forestry	I	1	L
Capparaceae	*Boscia senegalensis* (Pers.) Lam. ex. Poir	E. forestry	I	24	L
	Crataeva religiosa G.Forst.	E. forestry	I	4	L
Caricaceae	*Carica papaya L.*	Fruit species	E	19	L
Casuarinaceae	*Casuarina equisetifolia* J.R.Forst et G.Forst.	E. forestry	E	13	L
Celastraceae	*Maytenus senegalensis* (Lam.) Exell.	E. forestry	I	4	L
	Euonymus japonicus Thunb.	E. forestry	E	1	L
Combretaceae	*Combretum micranthum* G.Don	E. forestry	I	52	L
	Terminalia mantaly H.Perrier	E. forestry	E	15	L
	Combretum aculeatum Vent.	E. forestry	I	13	L
	Guiera senegalensis J.F. Gmel.	E. forestry	I	8	L
	Terminalia catappa L.	E. forestry	E	1	L
Commelinaceae	*Tradescantia zebrina* Heynh. ex. Bosse	E. forestry	E	1	H
Euphorbiaceae	*Hura crepitans* L.	E. forestry	I	12	L
	Euphorbia balsamifera Aiton	E. forestry	I	6	L

	Jatropha curcas L.	E. forestry	E	4	L
Loranthaceae	*Tapinanthus bangwensis* (Blume.) Rchb	E. forestry	I	1	L
Malvaceae	*Gossypium africanum* (Watt) Watt	E. forestry	E	1	L
Méliaceae	*Azadirachta indica* A.Juss	E. forestry	E	243	L
	Mangifera indica L.	Fruit species	E	124	L
Mimosaceae	*Prosopis juliflora* (Sw.) DC.	E. forestry	I	762	L
	Bauhinia rufescens Lam.	E. forestry	I	28	L
	Faidherbia albida (Delile.) A.Chev.	E. forestry	I	13	L
	Acacia senegal (L.) Wild.	E. forestry	I	12	L
	Acacia nilotica (L.) Wild. ex Delile	E. forestry	I	7	L
	Abrus precatorius L.	E. forestry	I	1	L
	Acacia seyal auct.	E. forestry	I	1	L
Moraceae	*Ficus sp* L.	E. forestry	E	52	L
	Ficus benjaminia L.	E. forestry	E	10	L
	Ficus vogelii (Miq.)Miq.	E. forestry	I	4	L
	Ficus thonningii Blume	E. forestry	I	1	L
Moringaceae	*Moringa oleifera* Lam.	Fruit species	E	84	L
Musaceae	*Musa sinensis* L.	Fruit species	E	7	H
Myrtaceae	*Eucalyptus camaldulensis* Dehnh.	E. forestry	E	70	L
	Psidium guajava L.	Fruit species	E	6	L
	Syzygium guineense (Wild.) DC.	E. forestry	I	2	L
Nyctaginaceae	*Boerhavia diffusa* auct.	E. forestry	I	1	H
Pinaceae	*Abies alba* Mill.	E. forestry	E	1	L
Poaceae	*Cymbopogon citratus* (DC.) Stapf	E. forestry	E	1	H
	Vetiveria nigritana (Benth.)Stapf	E. forestry	I	1	H
Polygonaceae	*Coccoloba uvifera* (L.)L.	E. forestry	E	2	L
Rhamnaceae	*Ziziphus mauritiana* Lam.	Forest Fruit species	I	65	L
Rosaceae	*Prunus cerasus* L.	Fruit species	E	7	L
Rubiaceae	*Mitragyna inermis* (Wild.) K. Schum.	E. forestry	I	5	L

Rutaceae	*Citrus limon* (L.)Burm.f.	Fruit species	E	30	L
	Citrus sinensis (L.) Osbeck	Fruit species	E	8	L
	Zanthoxylum zanthoxyloides (Lam.) *Zepem. Et Timler*	E. forestry	I	6	L
	Citrus reticuluta Blanco.	Fruit species	E	6	L
	Citrus clementina hort. ex Tanaka	Fruit species	E	4	L
	Citrus maxima (Burm.)Merr.	Fruit species	E	4	L
	Citrus aurantium L.	Fruit species	E	1	L
Sapotaceae	*Manilkara zapota* (L.)P. Royen	Fruit species	E	7	L
	Pouteria sapota (Jacq.) H.E.Moore et Stearn	Fruit species	E	7	L
Tiliaceae	*Grewia bicolor* Juiss	E. forestry	I	7	L
Verbenaceae	*Gmelina arborea* Roxb.	E. forestry	E	22	L
Vitaceae	*Cissus quadrangularis* L.	E. forestry	I	1	L
Zygophyllaceae	*Balanites eagyptiaca* (L.)Delile	E. Fruit forestry	I	86	L
	Guaicum officinale L.	E. forestry	E	1	L
38	***77***			**2973**	

E = introduced species (exotic); I = local (indigenous) species; H = herbaceous; L = woody.

Table 4: Floristic, biological and typological spectra of species in the commune of Mbour.

Families	**Proportion (%)**	**Species**	**Proportion (%)**	**Production**	**Proportion (%)**
Mimosaceae	27.72	*Prosopis juliflora*	*25.63*	Forest species	74.97
Apocynaceae	25.13	*Calotropis procera*	*22.81*	Fruit species	17.63
Meliaceae	12.34	*Azadirachta indica*	8.17	Forest fruit species	7.40
Araceae	7.06	*Cocos nucifera*	*6.29*	-	-
Combretaceae	3.13	*Mangifera indica*	*4.17*	-	-
Autres	24.62	*Autres*	*32.93*	-	-
Total	100.00	*Total*	*100.00*	*Total*	*100.00*

Table 5: Proportion of the species number according to the Caratini index.

Index	Species number	Proportion (%)	Qualifications
V	0	0.00	Constant
IV	2	2.60	Abundant
III	7	9.09	Fréquent
II	14	18.18	Accessory
I	54	70.13	Rare or accidental
Total	77	100.00	

Table 6: Floristic spectrum of roads in Mbour municipality.

Families	Proportion (%)	Species	Proportion (%)
Meliaceae	48.28	*Azadirachta indica*	*38.88*
Moraceae	15.63	*Cordia sebestena*	*10.42*
Boraginaceae	10.42	*Ficus sp*	*10.23*
Euphorbiaceae	8.00	*Khaya senegalensis*	*9.30*
Caesalpiniaceae	6.98	*Hura crepitans*	*8.00*
Verbenaceae	4.74	*Ficus thonningii*	*5.40*
-	-	*Delonix regia*	*4.93*
-	-	*Gmelina arborea*	*4.74*
Others	6.00	*Autres*	*8.09*
Total	100.00	*Total*	*100.00*

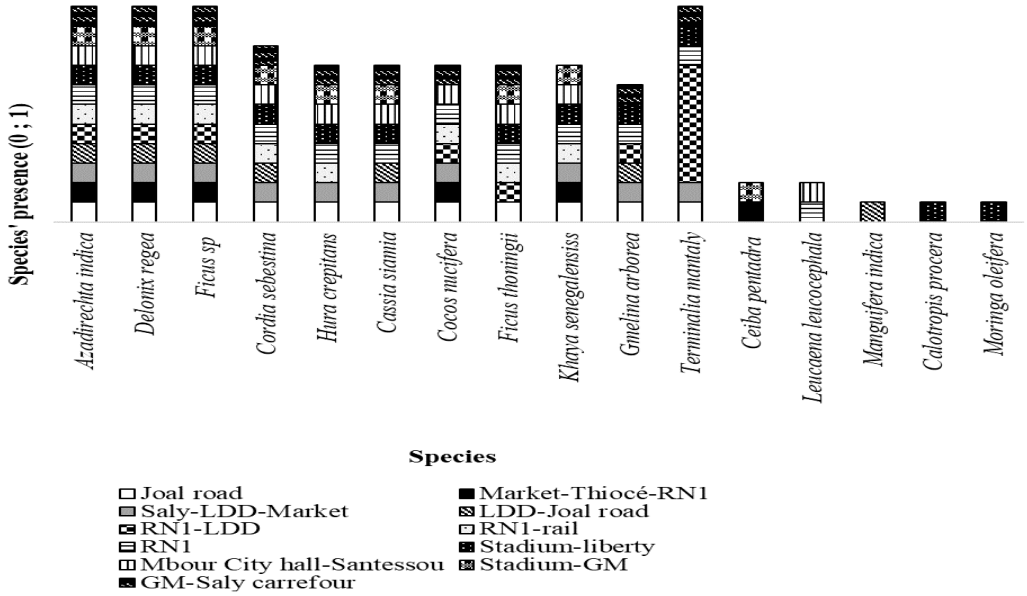

Figure 3: Species distribution in road axis.

NB : Joal: City hall of Mbour; Thiocé: District of Mbour; Saly: City hall of Mbour; LDD: Demba Diop Secondary School, GM: Grand Mbour; RN1: National Road 1; Liberty: District of Mbour; Saly Carrefour: District of Saly; Santessou: District of Mbour.

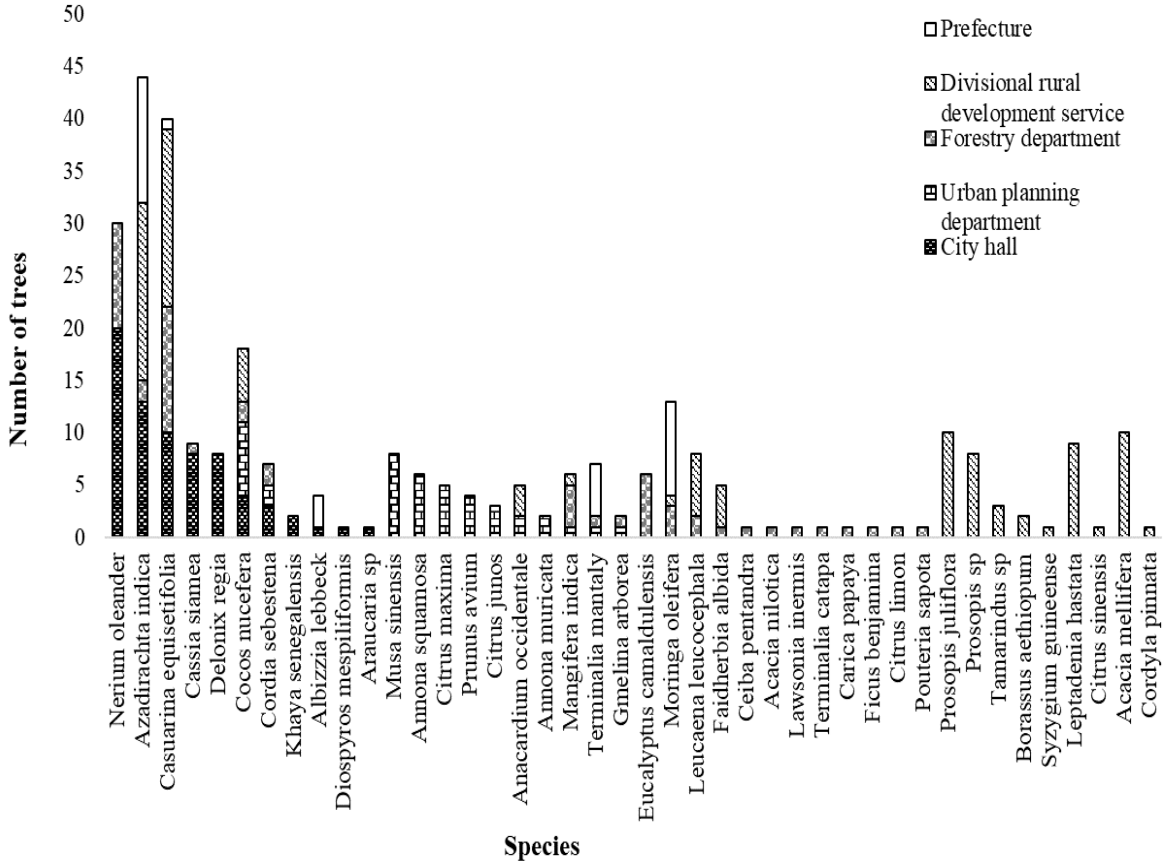

Figure 4: Distribution of species in technical structures.

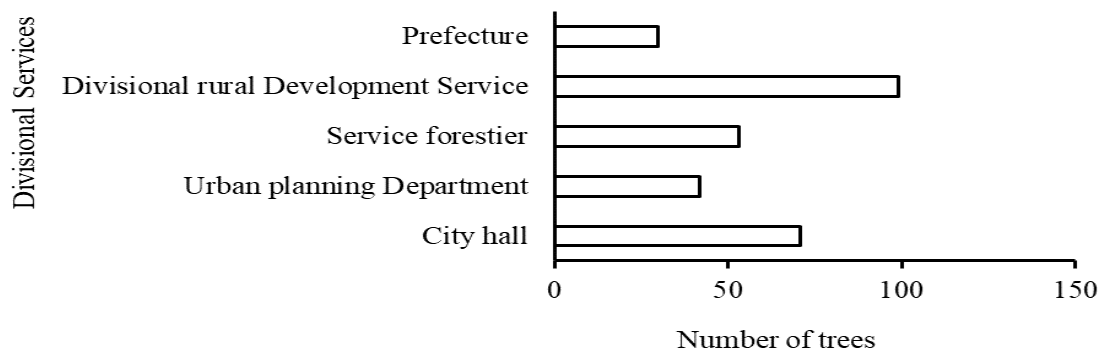

Figure 5: Individuals number per service.

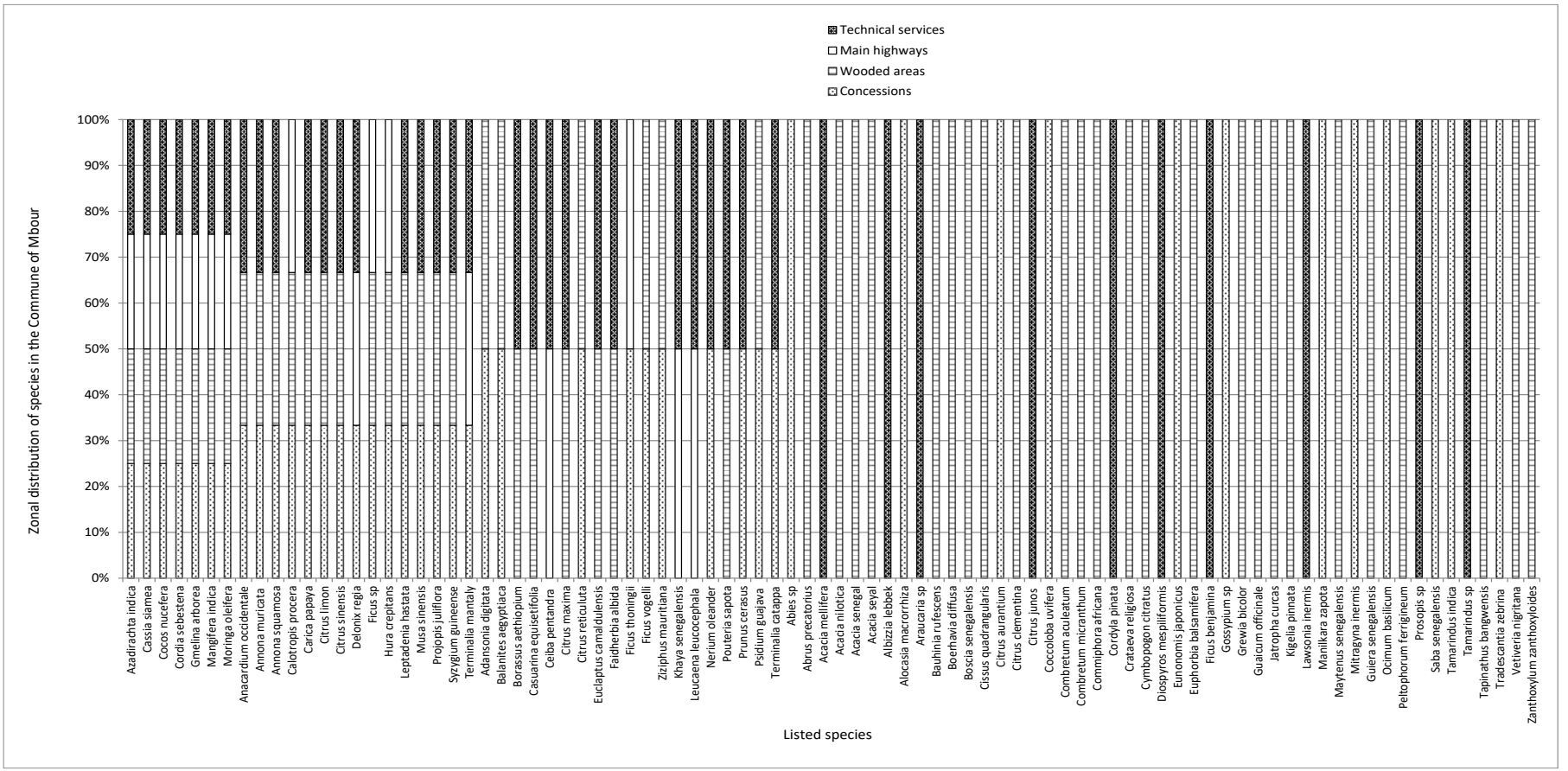

Figure 6: Distribution of woody flora in the Mbour municipality.

DISCUSSION

Plant diversity and importance of plantations in concessions and wooded areas

Although the municipality of Mbour is a tourist town and a transit area, little attention is paid to its urban forestry to make its landscape attractive. The inventory in the quarters and wooded areas in the municipality of Mbour presents 77 species divided into 38 families, a fairly rich floristic composition. Thus, Mimosaceae (27.72%), Apocynaceae (25.13%) and Meliaceae (12.72%) are the most important families. In the other hand, forest (74.97%) and fruit (17.63%) species are present. In addition, accessory species represent 18.18% against 9.09% for frequent species. Although the number of species obtained is lower, these results are similar to those recorded in Niamey city in Niger by Soulé et al. (2019). Niamey city includes 112 ligneous species belonging to 37 families. This diversity may be due to multiple uses of these species by the urban community such as temperature regulation and biodiversity support (Sjoman et al., 2016) and traditional medicine (Furakawa et al., 2016), also provided services by woody plants in Mbour city. Also, it may be due to human diversity as pointed out by Kuhn et al. (2004) who indicated that city species' diversity is correlated with urban landscape heterogeneity. This also indicates the role of Sahel cities in the woody biodiversity conservation like other cities in the world (Nero et al., 2017). Nowak et al. (2016b) and Yan and Yang (2017) pointed out that cities are important habitats for biodiversity conservation. In addition to this, there is a significant proportion of alien species in the Mbour commune urban forests surely because woody alien species provide valuable socio-economic and environmental services to city dwellers as pointed out by Davies et al. (2011) and Riley et al. (2018).

Exotic species predominance in the Sahel indicates that many of them are well adapted to severe climate conditions of this zone. This adaptation is important in climate change context as reported by Chalker-scott (2015). In addition, the predominance of exotic species has contributed to increased diversity (Chalker-scott, 2015), essential for ecosystem services provision (Kendal et al., 2014; Escobedo et al., 2015). Mimosaceae family (27.72%) has the largest number of species in Mbour municipality. This indicates that Mimosaceae family is adapted to harsh environmental conditions (Sreetheran et al., 2011) and plays an important role in atmospheric nitrogen fixation (Chaer et al., 2011). The dominance of Mimosaceae may be due to the various services provided by the species of this family. For example, on our list of Mimosaceae species, there are a few multipurpose species such as *Faidherbia albida* (Delile.) A. Chev., *Tamarindus indica* L., *Acacia senegal* (L.) Wild., *Acacia nilotica* (L.) Wild. ex Delile, etc. Indeed, this dominance may be due to the socio-economic importance of these species in terms of food production, medicines, fodder, etc.

The predominance of *Prosopis juliflora* (sw) DC. can be explained by its resistance to the drought which rages in the Sahel where the species was introduced for this reason. It might become invasive there with the corollary of appearance and multiplication of allergies according to Hamidou (2019). Fast growing, drought resistant and endowed with remarkable cutting power, *Prosopis* is a natural firewood candidate. With a specific gravity of 0.70 or more, its wood has been called "wooden anthracite" because of its high heat content, burning slowly and evenly, and retaining heat well. This species provides more than 90% in some Indian villages' firewood (Sharma et al., 1981). Although, no direct data on nitrogen fixation of *Prosopis* are available, Felker and Bandurski (1979) suggested that tree legumes (excluding Caesalpinioideae) fix between 155 and 580 kg/ha/year. Soils under leguminous crowns in the desert generally contain 10 times more nitrogen (0.3%) than those without nitrogen-free fixers (0-0.3%).

Plant diversity and importance of alignment plantations in Mbour municipality

In Mbour Commune, road linear plantations present a floristic diversity made up mostly with exotic species. The same observation was made by Vroh et al. (2014) on trees planted along the boulevards of plateau commune in Côte d'Ivoire. The floristic procession of Mbour road linear plantations is relatively weak with 16 species divided into 11 families. Studies carried out in other regions of the world present opposite results, and show that in most cities, the arboreal heritage in linear planting includes about thirty species and can be considered as being quite diversified. This is the Porto Novo case in Benin. Systematic road tree inventory, in this city, with a diameter at breast height (dbh ≥ 10 cm) and measured at 1.30 m from the ground displayed 1538 trees distributed among 35 species and 22 families (Osseni et al., 2020). Such a floristic heritage avoids phytosanitary problems linked to single species use in alignment (Bekkouch et al., 2011). The same observation was made by Dardor et al. (2014) according to whom, most of the time, plantations are made according to species availability on the market and not according to choices established on environment conditions basis.

Most representative species are *Azadirachta indica* A. Juss (38.88%), *Cordia sebestena* L. (10.42%), *Ficus sp.*, (10.23%), *Khaya senegalensi*s (Desr) A. Juss (9.30%). These four species account for 68.83% of trees in rod linear planting. From a statistical point of view, Kouadio et al. (2015) in a study on the same subject in Plateau and Cocody communes in Abidjan city had observed a dominance of four species representing 64% of recorded trees. But these species are not always the same as those identified in Mbour city. The same is true for Kouassi et al. (2018) who found a high frequency of five species out of around twenty counted in tree linear planting in Douala city, Cameroon. These findings are explained by the fact that these majority species are those valued in reforestation for shade functions and landscape aesthetics and carbon sequestration (Vroh et al., 2014). And to better exploit this potential, these species are introduced by citizens in alignments, with the aim of using the organs later. This results in a diversification linked to the choices of local residents, to whom greater attention should be given. Indeed, alignment plantations constitute a public heritage managed by both municipalities and forestry units. Thus, they should not be disturbed by the communities, as it occurs in Mbour for *Khaya senegalensis* (Desr) A. Juss. which is attacked and its frequency decreases over time. Because use of trees in public domain as well as in private sector is regulated by national law, Senegal forest code, number 2018-25 of November 12, 2018, to avoid these forms of illicit use of roadside trees for private purposes, establishment of community plantations made up with preferred species can be considered, given their importance for communities (Raymond and Simon, 2012). The socio-cultural context of Mbour agglomeration is a good illustration of this need to diversify plantations. This alternative is considered useful according to Morgenroth et al. (2015), for whom one of the means ensuring people well-being is vegetation integration taking into account human preferences. This practice also makes it possible to increase landscape socio-ecological value, considered as an essential element for the well-being of city dwellers. Moreover, specific diversification in urban areas is an advantage against pest invasions, according to a study by Raupp et al. (2006) in some cities in Northeastern United States of America.

Plant diversity and importance of plantations inside technical services of Mbour municipality

Knowledge of plant diversity in technical services makes it possible to better appreciate the importance given by authorities to improving populations' well-being by anticipating and optimizing development and management of urban greens spaces. Indeed,

technical services of Mbour Municipality include 42 species and 295 individuals distributed as follows: 21 species and 53 individuals for forest service, 17 and 99 for divisional rural development service (SDDR), 12 and 42 for town planning, 11 and 71 for town hall, 5 and 30 for prefecture. In addition, superiority of forest service in terms of species number is explained by the fact that this structure is in charge of forestry politics in the Mbour division. It has a nursery and can plant inside the service at any time.

SDDR has more individuals compared to other services because it has an inside garden. Unlike Lomé city in Togo (Botolisam et al., 2014), private garden are more floristically rich (67 species), followed respectively by public green spaces (31 species), tree-lined streets (29 species), private gardens (25 species) and playgrounds (15 species). On the other hand, similar results were obtained in Malika town in Senegal by Fall (2021), particularly in schools (20 species) and the Municipality space (11 species).

Conclusion

This study focuses on forestry plan. It showed that in urban areas, vegetation cover is very present in city center (densely vegetated districts) and weak in the outlying quarters (less densely vegetated quarters) of Mbour. Considering composition and floristic richness, more than sixty species have been counted in neighborhoods and wooded areas and more than ten species in main roads. Overall, 88 species have been identified in Mbour Commune. For sustainability of reforestation and planting activities, efforts should be made by various authorities (administrative, local or other) to strengthen quarters with less dense vegetation and consolidate quarters with dense vegetation. Hence, the necessity to continue actors' awareness and environmental education is still relevant as well as city wood parks creation to cover dwellers needs for better urban landscape preservation.

COMPETING INTERESTS

The authors declare that they have no competing interests.

AUTHORS' CONTRIBUTIONS

EF, MAT and HD contributed in protocol conception, implementation and article writing. They also participated in English writing. PDF participated in data collection, analysis and writing while MN contributed to overall correction and writing.

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