LOCAL PEOPLE'S PERCEPTIONS OF FOREST AND TREES ECOSYSTEM SERVICES: CASE OF KALOUNAYE MANAGED FOREST

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Abstract. Human use of vegetation has a long tradition in semi-arid West Africa, and local people highly appreciate the goods and services provided by woody plants. Our study aims to identify the ecosystem services of the Kalounaye managed forest and woody species for the surrounding villages in the communes of Ouonck and Coubalan. To do that, surveys based on individual interviews and focus group discussions and field observations were carried out. 179 individual interviews and 12 focus group discussions were done. A semi-structured with free-listing approach was used to collect ethno botanical and ecosystem services data. The importance attributed to each category of ecosystem services and species was evaluated using use value (UV), informant consensus factor (ICF), citation frequency (CF) and fidelity level (FL). Local people considered Provisioning services characterized by a use value of 79% as the most important forest and trees function. Cultural services (13%) were the second most important ecosystem services provided by forest and trees followed by regulating/supporting services (8%). A total of 27 species listed by the populations participated in the provision of ecosystem services. However, the informant consensus factor for ecosystem services was greater than 80%. The managed Kalounaye forest is rich in very important species that provided provisioning, regulating/supporting and cultural services for the surrounding populations.
Keywords: *forest, species, perceptions, ecosystem services*

Introduction

In most regions of the world, forests, trees on farms and agroforestry systems play important roles in the livelihoods of rural people by providing employment, energy, nutritious foods and a wide range of goods and environmental services (ITTO, 2014; Ickowitz et al., 2016; Vira et al., 2015). In addition to their functions of conservation and protection of natural and human resources, forests contribute to sustainable human development through the provision of ecosystem services. For example, forests are presented as areas for providing ecosystem services and demonstrating adaptation measures for resilience (Walker and Salt, 2012), which is a key argument for promoting biodiversity conservation (Myers, 1996). The term "Ecosystem services" can be defined in multiple ways, which illustrates the complexity of the concept (Danley and widmark, 2016). Ecosystem services can broadly be defined as the structures and functional attributes of ecosystems that result in the provisioning of goods and services that contribute to human well-being (Daily et al., 1997; Boyd and Banzhaf, 2007). Ecosystem services are all linked to human well-being either directly or indirectly. Direct services from forests and trees are represented by the provisioning of a wide range of products (wood and non- wood forest products) collected for food, feed, energy, construction and other uses. Indirect services are largely biophysical environmental processes that support the production of food in the long term, including access to clean water and nutrients, and enhanced quality of life (MEA, 2005).These

ecosystem services are divided by the Millennium Ecosystem Assessment (2005) into four groups: provisioning, regulating, supporting and cultural services. The provision of ecosystem services is now an emerging challenge that forests and trees can contribute to sustaining by the production of goods (food, wood, fiber, etc.) and the regulating and supporting services (carbon storage, maintenance of soil fertility, air and water purification, regulation of floods and droughts, pollination of plants, climate regulation, control of potentially invasive species and other pests, etc.) and the cultural or spiritual benefits.

Information is collected routinely on forests and trees and related management aspects. Measuring the social or socioeconomic and environmental benefits derived from forests and trees is much more challenging because of the lack of systematic data collection and the consequent scarcity of hard evidence to demonstrate societal and environmental benefits. Some assessments of the socio-economic and environmental benefits of forests and trees exist at the project or local level, and some data are collected at the national level, such as the contribution of forests and trees to gross domestic product and employment, and some of these are established at the global or regional levels (Rameststeiner and Whiteman, 2014). However, the collection and analysis of information on the socio-economic and environmental benefits of forests and trees are weak and need to be improved if the contributions of forests and trees to society are to be fully recognized.

The main objective of this study is to identify the different types of ecosystem services provided by the Kalounaye managed forest.

Review of Literature

Several ethnobotanical studies of the arid and semi-arid zones of Africa (Gning et al., 2013; Sarr et al., 2013; Dedoncker, 2013; Sop et al., 2012) have shown the importance of woody vegetation for well-being of surrounding communities. However, a number of ethnobotanical studies have been conducted on protected areas and in particular on classified forests (Cunningham, 2014; Gazzaneo et al., 2005; Mero Dowo et al., 2018). Human communities use ecosystems and, as a result, modify them locally and globally (Chevassus et al, 2019). These communities adjust their uses to the changes of ecosystems. This dynamic interaction is called socio-ecosystems (Walker et al., 2002). Indeed, one of the starting points is that human is an integral part of ecosystems, via a dynamic interaction between these two elements. To better consolidate the close relationship between forest ecosystems and human well-being, the State of Senegal is considering the management of these forests. Today, forest management in Senegal helps to protect and sustainably conserve the country's forest resources. Classified forests are bearing areas on terrestrial ecosystems that aim to promote solutions to reconcile biodiversity conservation with sustainable use (UNESCO, 1996). In the south of the country, forests are facing enormous disturbances (deforestation, bushfires, etc.) reducing their functionality. In Lower Casamance, particularly in the Kalounaye, the participatory management program of the Kalounaye managed forest is carried out in close collaboration with the forest service's and other parties. Well-managed forests have enormous potential for contributing to sustainable development.

Materials and Methods

Study area

The study was conducted in six villages (Ndiéba, Santack, Ouonck, Bouto, Kigninding and Mandouard 1) surrounding the Kalounayes classified forest. Ndiéba, Santack, Ouonck, Bouto, Kigninding are located in Ouonck Commune while Mandouard1 is located in Coubalan commune (*Figure 1*). These villages were selected to cover a range of surrounding communities of Kalounayes classified forest. Kalounayes classified forest is geographically located at 12°48'47" latitude north and 16°16'36" longitude west. Located at Bignona district, Ziguinchor province, Kalounayes classified forest covers an area of 15100 ha (Boyd and Banzhaf, 2007). The study area is located in sudano-guineen characterized by two seasons: long dry season and short raining season (five months) from June to November. The annual rainfall is highly variable and ranges between 812 and 1946 mm and characterized by mean annual rainfall of 1402 mm from 1996 to 2016.

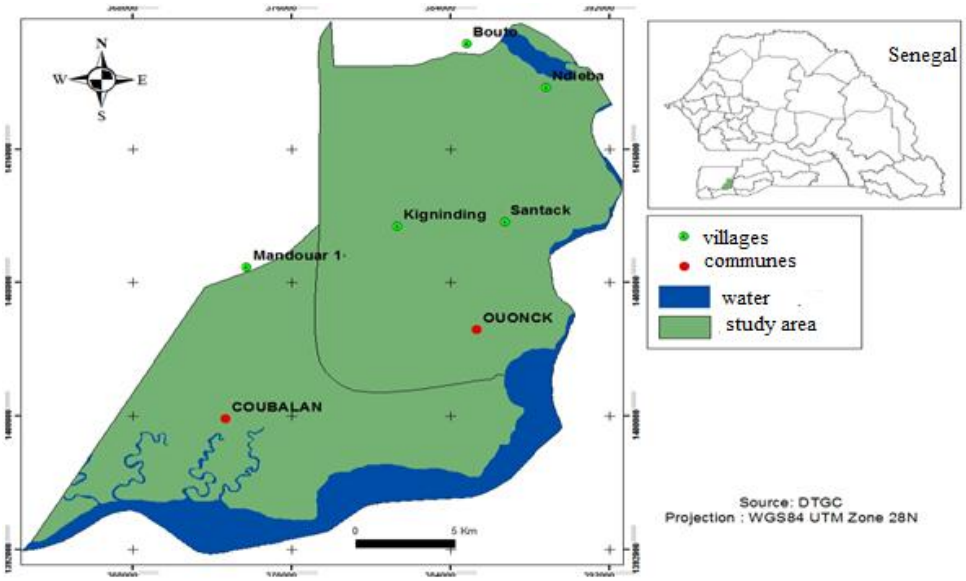

Figure 1. *Location of the six villages (Ndiéba, Santack, Ouonck, Bouto, Kigninding and Mandouard 1) in Ouonck and Coubalan communes, Bignona district Ziguinchor Province in Senegal.*

Sampling

The villages were selected through random sampling. Among the 37 villages surrounding the Kalounaye forest, six villages (Ndiéba, Santack, Ouonck, Bouto, Kigninding et Mandouard 1) were selected randomly for the interviews (*Figure 2*). Within each village, two groups were randomly selected for focus groups. In total, 12 groups were surveyed. For the individual interview, 179 people including 52 men, 69 women and 58 young people were selected randomly.

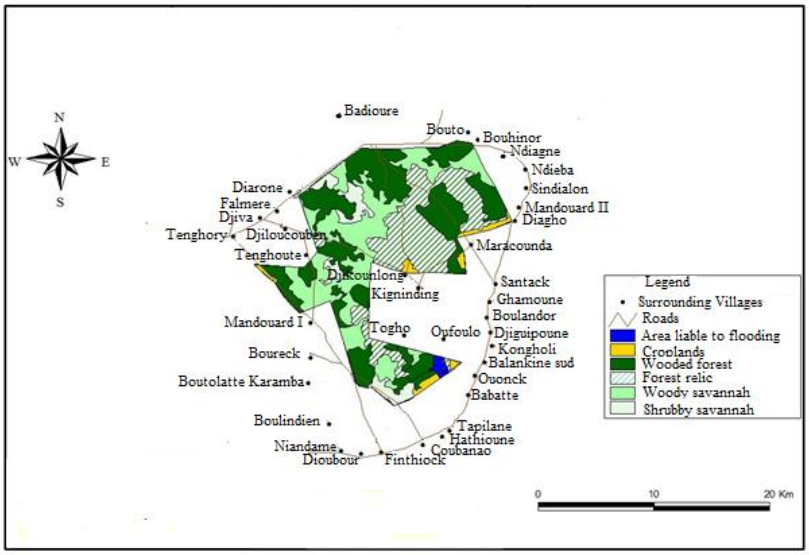

Figure 2. *Villages surrounding Kalounaye managed forest.*

Data collection

A semi-structured questionnaire with free-listing approach was designed and used for individual interviews and focus group discussions. The focus group discussions concerned groups such as sports and cultural associations (SCAs), economic interest groups (EIGs) and an organization called "ApoyaKaramba" which is an organization working for the protection and the conservation of Kalounayes forest resources, so each village having a representative. The survey covered various topic areas to capture data describing the participants and their views on the ecosystem services of Kalounayes forest and trees. For the validation of data on information revealed by the villagers during the two phases of surveys (focus group and interviews), a discussion group was organized in each village surveyed.

Data analysis

Data from group discussions, individual interviews, and observations were thematically analyzed as ecosystem services. The analysis focused on ecosystem services (provisioning, regulation/supporting and cultural services). To compare the importance and use of each ecosystem service and species, the citation frequency (CF), the use value (UV), the informant consensus factor (ICF) and the fidelity level (FL) were calculated. CF is the total number of citations for a particular service or species divided by the total number of respondents for that service/species. For each cited service or species, a use value (UV) as defined by Phillips et al. (1994) was quantified. Use value is a way of expressing the relative importance of each service/species to the population (Ayantunde et al., 2009; Sop et al., 2012) The level of consensus of the populations on the uses of the trees was determined by the computation of the informant consensus factor (ICF) defined by Heinrich et al. (1998). A high ICF value (closer to 1) is obtained when a single or a reduced number of species are cited by a large proportion of informants for a specific service category. On the other hand, ICF value is lower (close to 0) when a great diversity of species cited for the same use. FL of a species has been defined in relation to the different categories of use. FL is the percentage of

informants claiming the use of a certain plant for the same major purpose (Ugulu, 2012; Cheikhyoussef et al., 2011), was calculated for the cited species for ecosystem services.

Results

Ecosystem services

Participants' responses were strikingly homogeneous across all individual interviews and focus groups highlighting the major importance of goods that forests and trees provide for their direct or indirect uses. Local people considered Provisioning services characterized by a use value of 79% as the most important forest and trees function. Cultural services (12.5%) were the second most important ecosystem services provided by forest and trees followed by regulating/supporting services (8%). The informant consensus factors varied between 97 and 99% with the higher ICF were recorded in provisioning and cultural ecosystem services. A total of 27 species were used for different categories of ecosystem services. 100 % of the total number of species were used for provisioning, 67 % for regulating/supporting and 22 % for cultural services (*Table 1*).

Table 1. *Use value and informant consensus factor of ecosystem services.*

Ecosystem services	UV (%)	Number of species	ICF (%)
Provisioning	79.40	27	99
Regulating/supporting	8.10	18	97
Cultural	12.50	6	99

Provisioning services

Seven categories of provisioning services which were food, medicinal products, firewood, wood, construction, timber and fodder were mentioned by the informants. Within the provisioning services, food, medicinal product, firewood and fodder were considered the most important whereas wood, construction and timber were less important for local respondents. The informant consensus factor (ICF) varied between 96 and 99%. The informant consensus factor was more important for species used for food (99%) (*Table 2*).

Table 2. *Use value and informant consensus factor of provisioning ecosystem services.*

Provisioning services	UV (%)	Number of species	ICF (%)
Food	36.29	16	99
Medicinal products	23.76	19	98
Firewood	14.34	11	98
Wood	7.66	6	98
Construction	5.92	4	98
Timber	1.31	3	96
Fodder	10.69	7	98

27 species cited by the informants contributed to provisioning services. Among them, 16 species were used for food, 19 for medicine, 11 for firewood, six for wood, four for construction, three for timber and seven for fodder (*Table 2*). The most used species for provisioning services characterized by high UV were: *Z. mauritiana*, *P. erinaceus*, *B.*

akeassii, D. guineense, A. africana, E. guineensis, P. biglobosa, F. albida . Only seven species (*Annona senegalensis, Cassia sieberiana, Ceiba pentandra, Euphorbia balsamifera, Landolphia heudelotii, Saba senegalensis, Uvaria chance)* characterized by FL of 100% were used for one purpose. Most of species were recorded as being used for more than one purpose. Among the recorded species, *Khaya senegalensis* , *Parinari curatellifolia, Burkia africana, Parkia biglobosa, Pterocarpus erinaceus* , *Ziziphus mauritiana, Afzelia africana, Daniellia oliveri, Detarium senegalense* and *Spondias mombin* were the most used for many provisioning services (FL varying between 2 and 57%). The different uses of these species were: *Khaya senegalensis* (medicine, fodder, firewood, wood and contruction), *Parinari curatellifolia (food, medicine, firewood, wood* and construction), *Burkia africana (*medicine, firewood, wood and timber), *Parkia biglobosa (*food, medicine, fodder and firewood*), Pterocarpu serinaceus* (medicine, fodder, firewood and wood), *Ziziphus mauritiana* (food, medicine, fodder and firewood), *Afzelia africana* (medicine, fodder and wood), *Daniellia oliveri* (medicine, wood and timber), *Detarium senegalense* (food, medicine and firewood) and *Spondias mombin* (food, medicine and timber) (*Table 3*).

Table3. Use value, citation frequency and fidelity level of species providing provisioning ecosystem services.

Species	UV	Provisioning (in percentage %)													
		Food		Medicine		Fodder		Firewood		Wood		Construction		Timber	
		FC	NF	FC	NF	FC	NF	FC	NF	FC	NF	FC	NF	FC	NF
Adansonia digitata	1.05	90.5	84.81	13.96	15.18										
Afzelia africana	1.67			7.26	4.34	51.95	31.1			58.1	34.78				
Annona senegalensis	0.24	24.02	100												
Borassus akeassii	1.87	99.44	53.13									87.7	46.86		
Burkia africana	0.79			21.78	21.78			20.67	25.34	49.72	49.72			7.82	7.82
Cassia sieberiana	0.25			89.94	100										
Ceiba pentandra	0.29			29.05	100										
Cola cordifolia	1.13	58.1	50.98	55.86	49.01										
Combretum glutinosum	1.26			72.02	57.07			54.18	42.92						
Cordyla pinnata	0.13	8.37	62.5			5.02	37.5								
Daniellia oliveri	0. 13			2.79	20.83					3.91	29.16			6.7	50
Detarium senegalense	1.06	60.89	57.36	21.78	20.52			23.46	22.1						
Dialium guineense	1.76	96.64	54.74					79.88	42.25						
Elaeis guineensis	1.55	98.88	63.66									56.42	36.33		
Euphorbia balsamifera	0.01			1.11	100										
Faidherbia albida	1.41			66.48	47.03	74.86	52.96								
Guiera senegalensis	1.1			98.32	89.34			11.73	10.65						
Khaya senegalensis	1.32			55.3	41.59	11.73	8.82	11.73	8.82	34.63	26.05	19.55	14.7		
Landolphia heudelotii	0.84	84.91	100												
Neocarya macrophylla	0.54	44.13	80.61	10.61	19.38										
Parinari curatellifolia	1.08	59.77	61.84	9.49	8.76			27.37	28.32	9.49	8.76	2.23	2.06		
Parkia biglobosa	1.46	61.45	43.65	56.98	38.93	13.73	9.54	13.96	9.54						
Pterocarpu serinaceus	2.11			10.05	4.76	87.7	41.53	54.74	27.22	58.65	27.77				
Saba senegalensis	0.95	95.53	100												
Spondias mombin	0.63	31.84	50	9.49	14.91									22.34	35.08
Uvaria chance	0.09	9.49	100												
Ziziphus mauritiana	2.31	92.17	39.85	30.72	13.28	54.18	23.42	54.18	26.07						

Adansonia digitata	1.05	90.5	84.81	13.96	15.18

The most cited species used for food with high CF were: *B. akeassii* (99%), *E. guineensis* (99%), *Dialium guineense* (97%), *Saba senegalensis* (95%), *Ziziphus mauritiana* (92%), *Adansonia digitata*(90%), *Landolphia heudelotii*(85%), *Parkia biglobosa* (61%), *Detarium senegalense* (61%), *Parinari curatellifolia* (60%) and *Cola cordifolia* (58%). *G.senegalensis* was the most cited species followed by *C. sieberiana* and *combretum glutinosum* for the medicine (*Table 3*). Regarding the plant parts used for medicine, the leaves (31%) were the most used plant part and were followed by the barks (31%), roots (27%) and fruits (11%). The latex and the seeds were the least used plant part (*Figure 3*). *P. erinaceus* and *F. albida were the most used for fodder followed by Z. mauritiana* and *A. africana* . *Whereas, D. guineens, P. erinaceus, c. glutinosum* and *Z. mauritiana* were used as firewood by people with CF respectively of 80%, 55%, 54% and 54% (*Table 3*).

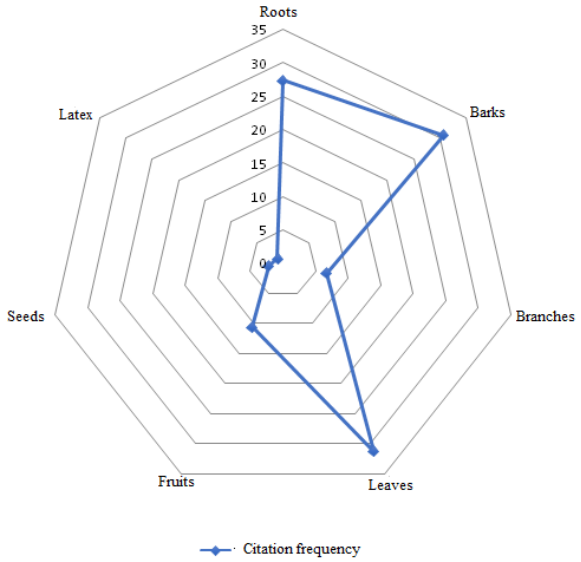

Figure 3. *Citation frequency of using plant parts for medicine.*

Regulation/supporting services

Six categories of regulating/supporting services (protection, climate regulation, precipitation, water purification, fertilisation and carbon sequestration) were reported by local people. Protection was the first category of regulating/supporting services provided by forest and trees with 37% of use expressions. It was followed by climate regulation , Carbon sequestration, precipitation , fertilisation and water purification. A total of 18 listed species contributed to the provision of regulating/supporting ecosystem services, including 56% of species were used for protection, 61% for Climate Regulation, 50% for precipitation, 22% for water purification, 28% for fertilization soil and 100% for carbon sequestration. The category that has the highest ICF value was protection (95%) followed by fertilisation (93%).The lowest was carbon sequestration (78%) (*Table 4*).The relative importance of each species was derived from its use value. The five species with the highest use values were: *K. senegalensis* , *C. pentandra* , *F. albida*, *P. erinaceus* and *C. cordifolia* (*Table 5*).

Table 4. *Use value and informant consensus factor of regulating/supporting ecosystem services.*

Regulation/supporting services	UV (%)	Number of species	ICF (%)
Protection	37.38	10	95
Climate regulation	19.56	11	89
Precipitation	11.74	9	86
Water purification	3.91	4	84
Fertilisation	11.74	5	93
Carbone sequestration	15.65	18	78

Table 5. Use value and informant consensus factor of regulating/supporting ecosystem services.

Species	UV	Regulating/supporting services (in percentage %)											
		Protection		Regulation		Precipitation		Water Purification		Fertilisation		Carbon sequestration	
		FC	NF	FC	NF	FC	NF	FC	NF	FC	NF	FC	NF
Adansonnia digitata	0.084			5.59	66.66	1.67	20					1.12	13.33
Afzelia africana	0.045							2.79	62.5			1.67	37.5
Burkia africana	0.123	8.38	68.18							1.67	13.64	2.23	18.18
Cassia sieberiana	0.004							1.12	40			1.67	60
Ceiba pentandra	0.302	19.55	64.81	5.59	18.52	2.23	7.41					2.79	9.26
Cola cordifolia	0.207	11.17	54.05	5.59	27.03	2.23	10.81					1.67	8.11
Cordyla pinnata	0.139	5.59	40	6.14	44					1.12	8	1.12	8
Daniellia oliveri	0.045							1.67	37.5			2.79	62.5
Detarium senegalense	0.134	8.94	66.66	1.12	8,33	2.23	16.66					1.12	8.33
Dialium guineense	0.045					2.79	62.5					1.67	37.5
Faidherbia albida	0.273			2.79	10.2	1.12	4.08			22.35	81.63	1.12	4.08
Khaya senegalensis	0.782	22.35	28.57	11.17	14.28	16.2	20.71	5.59	7.14	6.7	8.57	16.2	20.71
Neocarya macrophylla	0.022			1.12	75							1.12	25
Parinari curatellifolia	0.045	3.35	75									1.12	25
Parkia biglobosa	0.195	5.59	28.57	7.82	40	3.35	17.14			1.67	8.57	1.12	5.71
Pterocarpus erinaceus	0.24	16.76	69.77	4.47	18.6	1.67	6.98					1.12	4.65
Spondias mombin	0.106	5.03	47.37	4.47	42.1							1.12	10.53
Ziziphus mauritiana	0.039											3.91	100

Among the species mostly cited by the population for protection services, four were particularly distinguished with high citation frequencies: *K. senegalensis* (22%), *C. pentandra* (20%), *P. erinaceus* (17%) and *C.cordifolia* (11%). These four preferred species for protection services had high FL varying between 54 and 70%. For climate regulation, *K. senegalensis*, *P. biglobosa*, *C. pinnata*, *A. digitata*, *C. pentendra* and *C. cordyla* were the six most used species . However, the fidelity levels of these species varying between 14 and 67% revealed that climate regulation was one of the services they provided. With FL of 75%, *N. macrophylla* was more used for regulation than for other services. *K. senegalensis*, *Z. mauritiana*, *D. oliveri* and *C. pentandra* were the most cited for carbon sequestration with CF respectively of 16%, 4%, 3% and 3%. However, the FL of *K. senegalensis* (21%) and *C. pentandra* (9%) revealed that carbon sequestration was not only services they provided. At more than 45%, these species are cited by respondents for other uses; they are multipurpose species. With a very high FL, *Z. mauritiana*, *D. oliveri*, *C. sieberiana* and *N. macrophylla* were mostly used for carbon sequestration. The most used species for precipitation were *K. senegalensis* (16%), *P. biglobosa* (3%) and *D. guineense* (3%). In fact, the low FL of *K. senegalensis* and *P. biglobosa* is revealed that they were also in provision of regulating/supporting services. Forest resources were a source for fertilization of soil. Five most cited species for fertilisation were *F. albida*, *K. senegalensis*, *P. biglobosa*, *B. africana* and *D. oliveri*. Among the cited species, *F. albida* was the most frequently cited with a high level of fidelity (82%) (*Table 5*).

Cultural services

Three categories of cultural services (sacred wood, recreation and traditional wrestling) provided by the forest and species have been mentioned by people living around the forest. Among these categories, sacred wood is the most cited service provided by woody plants with 42% of expressions of use followed by leisure (34%) and traditional wrestling (24%) ICF was very high ranging between 98 and 99% for the six species used for cultural services (*Table 6*).

Table 6. *Use value and informant consensus factor of cultural ecosystem services.*

Cultural services	UV (%)	Number of species	ICF (%)
Sacred	41.7	4	99
Leisure	34.47	5	98
Rituals	23.83	2	99

The species with relatively high UV were *K. senegalensis*, *A.digitata*, *C. pentendra* and *S. senegalensis*. These species had multiple uses: *K. senegalensis* was used for all categories of cultural services while *A. digitata* and *C. pentendra* for sacred wood and recreation and *S. senegalensis* for only recreation. Among the species most used by the populations in the sacred wood, three were particularly distinguished with relatively high citation frequencies: *C. pentandra*, *K. senegalensis*, *C. cordifolia* and *A. digitata*. Within these four species, only two had high fidelity levels: *C. pentandra* (89%) and *C. cordifolia* (89%). Three species (*S. senegalensis*, *A. digitata* and *K. senegalensis*) with relatively high citation frequencies ranging from 39 to 56% were used for recreation: *S.senegalensis* (56%), *A. digitata* (45%) and *K. senegalensis* (39%). *S. senegalensis* is characterized by a very high fidelity level (100%). For traditional wrestling, the most

commonly used species were *K. senegalensis* and *B. akeassii* and *K. senegalensis*. *B. akeassii* with high fidelity level (100%) was characterized by its use which is exclusive to the traditional wrestling category (*Table 7*).

Table 7. *Use value, citation frequency and fidelity level of species providing cultural ecosystem services.*

Cultural services	UV	Culture services (in percentage %)					
		Sacred		Leisure		Rituals	
		FC	NF	FC	NF	FC	NF
Adansonnia digitata	0.78	32,96	42,45	44.69	57.55		
Ceiba pentandra	0.62	55,86	89,28	6.7	10.71		
Saba senegalensis	0.56			55.86	100		
Khaya senegalensis	1.54	49,16	31,88	39.11	25.36	65.92	42.75
Borassus akeassii	0.39					39.11	100
Cola cordifolia	0.51	45,81	89,13	5.59	10.87		

Discussion

Ecosystem services

Local people have reported a diversity of ecosystem services provided by forest and trees. People highly perceived direct and indirect ecosystem services (Martin-Lopez et al., 2012; Muhamad et al., 2014). Previous ethnobotanical studies have shown the importance of woody vegetation for well-being of surrounding communities of the arid and semi-arid zones of Africa (Gning et al., 2013; Sarr et al., Dedoncker, 2013; Sop et al., 2012). We found that provisioning and cultural services were perceived as the most important, compared with regulating/supporting services. This result is consistent with previous studies that have approached social aspects of ES assessment (Mensah, 2016 ; Hartel et al., 2014; Fagerholm et al., 2012; Hartter, 2010; Martin-Lopez et al., 2012). Among the provisioning ecosystem services, food, medicinal products, firewood and fodder were the most important according the local people. Another study carried out at the Greater Letaba Municipality (South Africa) showed that among the provisioning ecosystem services, timber, firewood and edible plants stood out as the most important (Mensah, 2016). However, the high rank in the importance of provisioning ecosystem services (especially food, medicinal products, firewood and fodder) followed by the cultural ecosystem services reflected more the level of awareness of local people of the function of forest by providing direct benefits. Food & fuelwood are fundamental for local people (Fagerholm et al., 2012). The interest of local people in these forest provisioning ecosystem services concurred with the ideas that rural communities showed a high appreciation of material benefits from forest ecosystems (Martin Lopez et al., 2012) and highly appreciated cultural services such as aesthetic value, recreational activities, tourism, environmental education (Burkhard et al., 2012). The fact that provisioning ecosystem services are often highly valued within rural inhabitants may be because they have a close connection to the ecosystems (Martin Lopez et al., 2012).

Relative importance of species

According to findings by Guèze et al. (2014), the more ecologically important a tree species is, the more uses it usually has. Our results thus highlight the usefulness of trees to ecosystem services at Kaloumaye managed classified forest. Of the 27 species listed by local populations, some have higher use values than others. Species with high use values in provisioning services are *Z. mauritiana*, *P. erinaceus*, *B. akeassii*, *D. guineense*, *A. africana*, *E. guineensis*, *P. biglobosa* and *F. albida*. The species with high use values in the regulating/supporting services are *K. senegalensis*, *C. pentandra*, *F. albida*, *P. erinaceus* and *C. cordifolia*. And finally, species the most used for cultural services are senegalensis, A. digitata, C. pentandra and S. senegalensis. Among the species most used by the populations for food, four (*B. akeassii*, *E. guineensis*, *Z. mauritiana* and *A. digitata*) are particularly distinguished with high citation frequencies. In fact, the fruits, seeds, leaves and gum of these species improve the nutritional status of rural populations (Sambou et al., 2016; Lykke et al., 2004; Sarr et al., 2013). The medicinal products are the second category of provisioning services cited by the population. The most used species for medicine are *G.senegalensis* and *C. sieberiana.* Based on the plant parts used for medicine, the leaves were the most used plant part and were followed by the barks, roots, fruits, branches and seeds. The widespread use of leaves for traditional medicine in our study is in accordance with the findings of Ricker (2002) in northern Nigeria, where leaves are the most widely plant part used for traditional medicine (Ayantunde et al., 2009). A third category of provisioning services provided the forest and trees is the firewood. Indeed, wood fuel in the form of firewood or charcoal is the main source of domestic energy for households (Sarr et al., 2013; Ayantunde et al., 2009). Four species (*C. glutinosum*, *Z. mauritiana*, *D. guineense* and *P. erinaceus*) are the most used in the supply of fuelwood. The use of trees in both food and medicine is related to the availability of target species and their high accessibility compared to other categories of provisioning services for firewood, wood, construction, timber and fodder (Gning et al., 2013).

Conclusion

This study revealed the importance of woody species for local populations in the Kalounaye managed forest. The woody stands of this forest contribute to the provision of three types of ecosystem services (provisioning, regulating/supporting and cultural ecosystem services). The importance and use of ecosystem services were assessed within local communities of a region in Senegal. It was found that these local communities valued forest and trees provisioning services (food, medicinal products, wood, construction, timber and fodder) more than regulating/supporting and cultural services. The high use values of some woody species show the need to reduce pressure on woody resources. The results further highlighted that respondents' perceptions about ecosystem service importance reflect their actual use of these services. These results are important, and should be taken into account for management of ecosystem services in local development planning.

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