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Ecological Survey of Phanerophytes on Federal College of Education (Technical) Gombe Campus, Gombe-Nigeria.

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Abstract: For effective teaching-learning process in any institution of learning, suitable conditions of both teaching materials and environmental condition are of paramount importance. Environmental condition plays a vital role, positively or otherwise, in effective teaching-learning process. This study surveyed phanerophytes on federal college of education (Technical), Gombe campus. Four sites were selected using deliberate sampling technique namely, Administrative block, Students' hostels, Classes area and Staff quarters. Results obtained identified 14 different species of phanerophytes belonging to 11 families with the highest record of species diversity at Staff quarters. Higher values of relative density, basal area, relative dominance and importance value indices were recorded on Azadirachta indica and Parkia biglobosa. Importance value indices suggested Azadirachta-Parkia type of vegetation complex on the college campus. Introduction of exotic species in afforestation program was recommended for FCET, Gombe so as to increase the vegetation cover of the college campus among other recommendations.

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INTRODUCTION

For effective teaching-learning process in any institution of learning, suitable conditions of both teaching materials and environmental condition are of paramount importance. Environmental condition plays a vital role, positively or otherwise, in effective teaching- learning process. For example, buildings and vegetation shade were reported to lower air temperature (Agus, 2003) which invariably enhances effective learning process especially in the harsh weather of tropical countries like Nigeria.

Gombe state is one of the six states in the north-east of Nigeria, which is the extreme part, bordering the desert area of Niger republic. It is characterized by high temperature (up to 45^0 c) in the month of March –June. This soaring temperature is detrimental to teaching-learning process especially with the epileptic nature of electricity supply in the region to run the little fans available in the classrooms that are devoid of air conditioning system. Availability of trees (phanerophytes) is the only solution in lowering this temperature by creating a micro-climate of low temperature, adequate shade and oxygen supply. The importance of vegetation to man cannot be over emphasized. One of the basic benefits of trees is replenishing the environment with oxygen, which is a bye product of photosynthesis. Edible fruits are also obtained from trees. Vegetation shade also reduces exposure of man to harmful ultraviolet radiation thereby minimizing the possibility of melanoma (Parisi, 2002). Provision of quality living and learning setting is crucial for staff and students on campuses just as green area network greenery and interconnected open spaces formed by tree streets, waterways and drainage ways around and between urban areas, at all spatial scales are important where people can use it to reach places of work or study (Toccolini, 2006). In fact Campus greenery promotes healthy society (Tzoulas, 2007) and is one of the approaches taken to achieve an environmentally good campus through improving and maintaining all the landscape elements on campus as well as other recreational facilities (Habib and Ismaila, 2008). This means greenery and open spaces are not just amenities but also an interconnected network of ecological systems that conserve air, water, microclimate, energy resources and enriches human quality of life.

Campuses are growing each year with the enrolment of new students; more space is needed to accommodate hostels, road signage for managing traffic flows, new schools for new courses as well as parking space. Uncertainty in the student's enrolment was complicated as universities are changing in unpredictable ways (Turner, 1984). This turns campuses into a clog development area. Campus sustainability has become a global issue

among the university administrators, policy makers, planners as well as stakeholders (Habib and Ismaila, 2008). The development for campus infrastructure should be provided or maintained without jeopardizing the quality of campus environment (Balsas, 2003). Campuses are losing green spaces due to the increasing need for more spaces for parking, new buildings and campus housing area (Balsas, 2003). Although some studies revealed that the existence of tree does not always give positive human preference (Theriaut et.;al 2002), such studies may be relevant only in the context of non-tropical countries where sunlight is required especially in winter when vegetation shade is detrimental to heat requirement. In tropical countries, studies revealed significant relationship between shade and air temperature (Agus, 2003) as people patronize under shade for relatively low temperature. In view of this, tree plants are of paramount importance on campuses in tropical countries in order to bring cooling effects, aesthetic value, purification of air and windbreaks for the harsh environment thereby enhancing teaching-leaning process.

Gombe state is facing serious desertification as the national forest conservation council of Nigeria (NFCCN) reported in Sunday Trust (Kabiru, 13th April, 2008) that the state is one of the eleven northern Nigeria states with desert encroachment at an estimated rate of between 8 - 30 hectares per annum. The other states are Borno, Yobe, Bauchi, Adamawa, Jigawa, Kano, Katsina, Zamfara, Sokoto and Kebbi. This signifies low tree plants in these states which are required for shade production, windbreaks and oxygen supply.

The menace of deforestation is not peculiar to the northern part of Nigeria alone. It is believed that before the establishment of University of Lagos the biodiversity of Lagos (in the south) was covered with huge lush of Mangrove forest, but the rapid urbanization from the 1970s onwards that followed a series of successive redevelopments for higher intensity land use has done away with most of this vegetation cover (Nodza, Onuminya & Ogundipe, 2014). Although the main drivers of deforestation in the country have been outlined and highlighted by several authors, (Alamu and Agbeja 2011; Pelemo, et al., 2011;) to include agriculture, logging and mining, use of fuel wood and logging amongst others, these pose various degree of threats to biodiversity conservation in Nigeria. However habitat conversion into residential area (urbanization), indiscriminate degradation and reclamation of mangrove for development of several infrastructural facilities in order to satisfy the insatiable human's wants, and subsistence farming were observed to be the stringent problems facing the flora of University of Lagos (Nodza, Onuminya & Ogundipe, 2014). In fact, the entire vegetation in the University campus has been degraded such that the secondary vegetation and Mangrove forest are cleared to build public housing or infrastructures; drainage patterns were drastically changed, and streams are straightened, redirected and made into concretized canals and ditches (Nodza, *et.al.*, 2014).

In Federal College of Education (Technical) Gombe (FCET) buildings for classrooms, office accommodations and theaters are the major causes of deforestation on the campus. Rapid increase in population have led to the development of several infrastructural facilities for the provision of comfort to the insatiable humans wants have, of course, led to the destruction of almost all the ancestral vegetation in and within the study area. But the aspect of development that seems not apparently noticeable in F.C.E. (T), Gombe is the area of landscaping and ornamentation which, as part of aesthetic value, enhances a micro-climate condition that supports conducive teaching-learning process in an institution of learning This research studied the population, species composition and importance value index (IVI) of phanerophytes on the FCE(T) campus with the view to assessing the position of trees on the campus.

Objectives of the Study

This study has the general aim of assessing the phanerophyte on the FCET campus with the following specific objectives:-

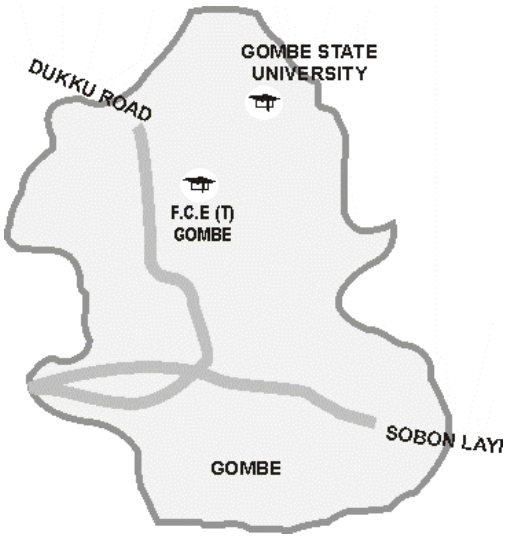
1. Evaluation of phytosociology of phanerophytes on the FCET campus
2. Naming the vegetation type on the FCET campus

MATERIALS AND METHOD

Study Area

The college is located along Gombe –Ashaka road, in Gombe. It has a land mass of about 476.2 hectares. It is one of the twenty-two federal colleges of education in Nigeria that awards the Nigeria certificate in Education (NCE), the minimum qualification for teaching in Nigeria. It was established in 1977, then as National Technical Teachers college (NTTC). In 1985, it was renamed as FCET, Gombe. The college has six schools presently, namely school of Business education, school of education, school of science education, school of technical education, school of primary education studies and school of vocational education. The college offers degree programme in affiliation with University of Maiduguri and Abubakar Tafawa Balewa University, Bauchi. It also awards NCE through weekend programme. The college has a company registered as GOFCECON LTD through which, among other things, wards certificate and diploma in computer.

Of recent, University of Maiduguri, through the college, has introduced a degree awarding program through distance learning programme in the college.



Map of Gombe Town showing the Study Area.

Procedure for Data Collection

Wandering quarter method of vegetation analysis was used for the study. This is a method of sampling plant community using plotless survey technique whereby a researcher obtain data on the community by zig-zag movement from one tree to another heading in the same general compass direction (Kell,2006). Data collected was used to calculate several common measures of plant community structure including, species richness, species diversity, relative basal area, stem per hectare, relative dominance, and importance value index (IVI)

The following steps were observed in using this method:-

(1) A starting point was randomly selected avoiding edge area in the site of study. A compass line was then selected from the starting point that led into the stands of the trees studied

(2) While standing at the starting point and sighting within an angle of 90^o 45^o on either side of the compass line, the nearest tree (of not less than 10cm circumference) whose center lies within the inclusion angle was considered the first sampled tree.

(3) The species name was determined using the dichotomous key. In case of failure to properly name the species encountered, sample of leaves, flowers and fruits (where found) were collected and taken to ATBU herbarium for identification.

(4) Circumference (in cm) at breast height (CBH) of the tree and distance from the starting point were also recorded.

(5) From the first tree sample, sighting along the compass line again, the second nearest tree within the 90^o inclusion angle was selected. The same parameters were again recorded.

(6) Step five was repeated severally thus wandering about until 100m of distance was covered maintaining the same general compass direction.

Method for Data Analysis

Data from wandering quarter method were calculated using the following formulae (Kell, 2006):-

(1) Calculating Relative Density of each species

Relative Density= Number of Individuals of a species / Total number of trees counted x 100

(2) Calculating Basal area of each tree

Basal area= $\pi (r)^2$. But r= circumference at breast height/ 2π

(3) Calculating basal area of each species

Total the basal area of trees of the same species

(4) Calculating basal area for all species

Total the basal area of all species encountered

(5) Calculating relative dominance

Relative dominance= Basal area per species/ Total basal area of all species x 100

(6) Calculating IVI of each species

IVI= Relative density+ relative dominance

(7) Calculating mean distance (d_m) between trees (in metres)

d_m = sum of all distances/ number of distance measurements

(8) Calculating the mean area (MA) of all trees

MA= $(d_m)^2$

(9) Calculating density (D) of all trees (in trunk) per unit area

D= A/MA (where A= unit area i.e. a hectare, which is $10{,}000m^2$)

Thus D= $10{,}000m^2$ /MA which gives density of trees in trunk per hectare.

This is a measure of number of trees per one hectare of land

(10) Calculating the basal area per hectare

Divide the total area (from #4 above) by the number of trees measured to get mean basal area per hectare. Then multiply mean basal area by density (from #9) to get basal area per hectare. This will give an estimate, based on the sample, of how much wood are there per hectare.

RESULTS

Species encountered during the study and their families

A total of fourteen (14) different species of trees were encountered during the study, belonging to eleven (11) families (Table 1)

Table 1: Species encountered during the study and their families

S/N	Family	Species
1	*Azadirachta indica* A.Juss	Meliaceae
2	*Parkia bigloboso* (Jacq.) Bent.	Mimosaceae
3	*Delonix regia* (Bojer ex Hook.) Raf	Leguminosae
4	*Gmelina arborea* Roxb	Verbenaceae
5	*Khaya senegalensis* .(Dev.) A.Juss	Meliaceae
6	*Tamarindus indica* .L.	Leguminosae
7	*Eucalyptus globulus.* Labill	Myrtaceae
8	*Mangifera indica* L.	Anacardiaceae
9	*Piliostigma thonningii* (schum.)	Fabaceae
10	*Acacia sieberiana.* DC	Fabaceae
11	*Acacia albida Del.*	Mimogaceae
12	*Gueira senegalensis* (J.F. Gmel.)	Combretaceae
13	**Sterculia setigera**. Del.	Malvaceae
14	*Adansonia digitata* .L.	Bombacaceae

Relative Densities of Species at the Four Sites Studied

Relative density of species at the administrative block (Table 2) indicated highest value (66.8) on *Azadirachta indica* with the lowest of 4.0 on *Khaya senegalensis* but at students' hostels (Table 3) relative densities revealed the highest value of 75.4 on *Azadirachta indica* with the least of 1.6 on *Eucalyptus eucalyptus*

Table 2: Reletive Densities of Species at Administrative Block Site

S/N	Species	R. Density(%)
1	*Azadirachta indica*	66.8
2	*Parkia biglobosa*	18.0
3	*Delonix regia*	04.8
4	*Gmelina arborea*	06.4
5	*Khaya senegalensis*	04.0

Table 3: Relative Densities of Species at Students' Hostels

S/N	Species	R. Density(%)
1	*Azadirachta indica*	75.4
2	*Parkia biglobosa*	13.2
3	*Tamarindus indica*	09.8
4	*Eucalyptus eucalyptus*	01.6

Values for relative densities of species encountered in students'classes area (Table 4) shows the highest value (47.6) on *Azadirachta indica* with the lowest value of 2.4 recorded on *Mangifera indica* whereas Table 5 indicated the relative densities of species at staff quarters with the highest value (36.4) on *Azadirachta indica* with the lowest record on Adansonia digitata *(1.5). Acacia sieberiana* and *Acacia albida* both showed a staggering 5.3 percent each.

Basal Area and Relative Dominance for Species at the Four Sites Studied

Basal area and relative dominance for species encountered at administrative block (Table 6) indicated highest values of 6955.9 and 37.3 respectively on *Azadirachta indica* with the lowest records on *Gmelina arborea* (1752 & 9.4 respectively).

Records of basal area and relative dominance of species around students hostels (Table 7), however, showed slightly higher values (9175.0 & 49.2 respectively) for the same species, *Azadirachta indica*, with lower records of 671.3 and 3.6 respectively on *Tamarindus indica*

Table 4: Relative Density of Species in Classes Area

S/N	Species	R. Density(%)
1	*Azadirachta indica*	47.6
2	*Parkia biglobosa*	26.2
3	*Eucalyptus eucalyptus*	14.3
4	*Khaya senegalensis*	09.5
5	*Mangifera indica*	02.4

Table 5: Relative Densities of Species at Staff Quarters

S/N	Species	R. Density (%)
1	*Azadirachta indica*	36.4
2	*Parkia biglobosa*	17.4
3	*Piliostigma thonningi*	14.4
4	*Anogeissus leiocarpus*	13.6
5	*Acacia sieberiana*	05.3
6	*Acacia albida*	05.3
7	*Gueira Senegalensis*	03.8
8	**Sterculia setigera**	2.3
9	**Adansonia digitata**	1.5

Table 6: Basal area and relative dominance for species encountered at administrative block

S/N	Species	B. Area.(cm)	R. Dom. (%)
1	*Azadirachta indica*	6955.9	37.3
2	*Parkia biglobosa*	5311.0	28.4
3	*Delonix regia*	2704.0	14.5
4	*Khaya senegalensis*	1939.4	10.4
5	*Gmelina arborea*	1752.9	9.4

Table 7: Basal area and relative dominance for species encountered at students' hostels

S/N	Species	B. Area.(cm)	R. Dom. (%)
1	*Azadirachta indica*	9175.0	49.2
2	*Parkia biglobosa*	6862.6	36.8
3	*Eucalyptus eucalyptus*	1939.4	10.4
4	*Tamarindus indica*	671.3	3.6

Values for basal area and relative dominance of species within classes' area (Table 8) also indicated high records of 6750.1 and 36.2 respectively on *Azadirachta indica* with the lowest values (1715.7 & 9.2 respectively) on *Mangifera indica*.

At the staff quarters, however, though *Azadirachta indica* recorded the highest values of 4270.5 and 22.9 respectively, the lowest records of 671.3 and 3.6 basal area and relative dominance respectively was observed on *Gueira Senegalensis* (Table 9).

Table 8: Basal area and relative dominance for species encountered at classes area

S/N	Species	B. Area.(cm)	R. Dom. (%)
1	*Azadirachta indica*	6750.1	36.2
2	*Parkia biglobosa*	5109.7	27.4
3	*Khaya senegalensis*	3587.6	14.6
4	*Eucalyptus eucalyptus*	2349.7	12.6
5	*Mangifera indica*	1715.7	9.2

Table 9: Basal area and relative dominance for species encountered at staff quarters

S/N	Species	B. Area.(cm)	R. Dom. (%)
1	*Azadirachta indica*	4270.5	22.9
2	*Parkia biglobosa*	3431.3	18.4
3	*Anogeissus leiocarpus*	3207.5	17.2
4	Adansonia digitata	1939.4	10.4
5	*Piliostigma thonningi*	1902.1	10.2
6	*Acacia sieberiana*	1827.5	9.8
7	*Acacia albida*	708.6	3.8
8	Sterculia setigera	690.0	3.7
9	*Gueira Senegalensis*	671.3	3.6

Mean distance (d_m) between Trees and Mean Area (MA) of all Trees in all sites studied (in meters)

of mean distance (d_m) between Trees (Table 10) showed students hostel recorded highest distance (12.4m) between trees with a corresponding highest mean distance of 86.8m. Lowest record of mean distance was observed at staff quarters (6.2m) with a corresponding mean area round individual trees of 43.3m

Table 11, however, showed highest density of individual trees (101) per hectare at staff quarters with the lowest value of 67 trees per hectare at students" hostels

Table 10: Mean distance (d_m) between Trees and Mean Area (MA) of all Trees in all sites studied (in meters)

S/N	Characteristics	Admin Area	Hostels	Classes Area	Staff Quarters
1	Mean Distance	9.8m	12.4m	8.7m	6.2m
2	Mean Area	68.6	86.8	60.9	43.4

Table 11: Density of Tree per hectare in all four sites studied (approx. whole number)

	Characteristics	Admin Area	Hostels	Classes Area	Staff Quarters
1	Density	84	67	89	101

Importance Value Indices for each Species of Plant in the four Communities

The highest importance value index was recorded on *Azadirachta indica* with a total of 371.7 for all the four sites. The records for same species in respective sites indicated the highest value of 124.6 at students' hostel. The second highest record was observed on *Parkia bigloboso* with a toal record of 185.8 for all the four sites. The site with the highest individual record (50.0) was the students' hostel. Lowest IVI of 6.0 was observed on Sterculia setigera at staff quarters.

It pertinent to note, however, that the two most frequently occurring species in all the four sites studied are still *Azadirachta indica and Parkia bigloboso.*

DISCUSSION

Table 1 suggested the species diversity in all the four sites which shows low species (14) and only *Azadirachta indica*, *Delonix regia*, *Gmelina arborea*, *Eucalyptus eucalyptus* may be considered as exotic. This suggested very low reforestation effort of the college community. After clearing the site for infrastructural development, local species were mostly done away with. For good vegetation cover on the campus, exotic species needs to be encouraged. However, contrary is the case with high number of local species more than the exotic varieties. This agreed with the findings of Umar *et.al.*, (2014) which shows low species diversity on FCET campus in comparison with Gombe state university campus vegetation cover with most of the species on FCET campus being local species.

Results also shows *Azadirachta indica* recorded the highest relative density in all four sites studied (Tables 1-4). This may not be unconnected with the fact that the species was among the early exotic verities that were introduced to this part of the country and proved to be striving well. Due to the conducive nature of the soil and atmospheric condition of northern Nigeria for this species, it germinates even on natural dispersal without much attention given to it. This was further justified by the frequency of the species in all the four sites along with *Parkia bigloboso.* The least relative density of Khaya senegalensis (4.0) at Adminstrative block, *Eucalyptus eucalyptus* (1.6) at students' hostel, *Mangifera indica* (2.4) at classes' area and *Adansonia digitata* (1.5) at staff quarters may be attributed to the exotic nature of the first two and the economic importance of the last two respectively.

Table 12: Importance Value Indices for each Species of Plant in the four Communities

S/N	Species	Admin. Block	Students' Hostels	Classes Area	Staff quarters	**Total IVI**
1	*Azadirachta indica*	104.1	124.6	83.8	59.2	**371.7**
2	*Parkia bigloboso* (Jacq.) Bent.	46.4	50.0	53.6	35.8	**185.8**
3	*Delonix regia*	19.3	-	-	-	19.3
4	*Gmelina arborea*	15.8	-	-	-	15.8
5	Khaya senegalensis.(Dev.) A.Juss	14.4	-	24.1	-	38.5
6	*Tamarindus indica* .L.	-	13.4	-	-	13.4
7	*Eucalyptus eucalyptus*	-	12.0	26.9	-	38.9
8	*Mangifera indica*	-	-	11.6	-	11.6
9	*Piliostigma thonningii* (schum.)	-	-	-	24.6	24.6
10	*Acacia sieberiana.* DC	-	-	-	15.1	15.1
11	*Acacia albida Del.*	-	-	-	9.1	9.1
12	*Gueira senegalensis* (J.F. Gmel.)	-	-	-	7.4	7.4
13	**Sterculia setigera**. Del.	-	-	-	6.0	6.0
14	*Adansonia digitata* .L.	-	-	-	11.9	11.9

Being exotic shows that the college community has less concern for encouraging exotic species, a factor observed by Umar, *et.al* (2014) also, thus low relative density while being of high economic importance, with respect to the last two, it indicates high human activity on these species therefore the low relative density on *Mangifera* and *Adansonia* due to patronage on the species.

Results on basal area suggested higher records on *Azadirachta indica* in all the four sites of study, a factor attributed to its dominance (as high as 49.2% in students' hostel) in the campus. The lowest value of basal area (671.3cm) was recorded on *Gueira senegalensis* (Table 9), a possible reason may be the shrub nature of the species with low diameter of girth.

Based on the importance value of the species (Table 12), *Azadirachta indica* and *Parkia bigloboso* stood out as the two most important species (finding that concurred with that of Umar *et.al*,2014 that observed older local species on FCET campus compared to Gombe state university vegetation) with IVI values of 371.7 and 185.8 respectively. The third species after these two species recorded 38.9 for *Eucalyptus* spp, a gap too wide to be considered in naming the vegetation type of the campus.

By this values, the vegetation type of FCET, Gombe campus can be referred to as ***Azadirachta-Parkia*** complex type of vegetation.

Summary

Availability of trees (phanerophytes) is the only solution in lowering high temperature in areas of north-eastern states of Nigeria by creating a micro-climate of low temperature, adequate shade and oxygen supply. This study, therefore, surveyed phanerophytes on FCET, Gombe campus with the view to assess and name the type of vegetation on the campus. Survey design was used to study trees of not less than 10cm using wandering quarter method of vegetation analysis in four sites, namely, Administrative block, Students' hostels, Classes area and Staff quarters. Results obtained identified 14 different species of phanerophytes belonging to 11 families with the highest record of species diversity at Staff quarters. Higher values of relative density, basal area, relative dominance and importance value indices were recorded *Azadirachta indica* and *Parkia biglobosa.* Importance value indices suggested *Azadirachta-Parkia* type of vegetation complex on the college campus.

CONCLUSION

In view of the results obtained, it is logical to conclude that FCET, Gombe management and, indeed, the college community have less concern for afforestation program considering the total species (14) identified on the campus. This was further justified by the highest species diversity (9 species) obtained only at the staff quarters, an area that is relatively undisturbed except for the space used for establishing the few housing units. Whereas the activity dominated areas (Admin, hostel & class area) had predominantly low number of species and are mainly local varieties.

RECOMMENDATION

The following recommendations were suggested:-

1. Introduction of exotic species in afforestation program is recommended for FCET, Gombe so as to increase the vegetation cover of the college campus
2. Existing phanerophytes should be cared for so as to nurse them to full grown size for maximum benefits
3. Ornamental plants are also recommended for landscaping and beautification on the campus

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