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Impact of seasonal changes on the vegetation composition of some selected areas in Lagos state, Nigeria

Peter Adegbenga Adeonipekun[1], Oyetola Olusegun Oyebanji[1] & Michael Babatunde Adebayo[1]

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Abstract. Rapid degradation of wetlands and habitat fragmentation are major threats to species diversity and ecological paradigm in Lagos state, Nigeria. Best to our knowledge, no empirical study has explored the effects of seasonal changes on covering three major cities in the statewithin the major cities in Lagos state. For this, we carried out a study covering the three major cities in Lagos: Badagry, Epe and Ikorodu. Permanent plots were randomly established for monthly data collection (quadrat method; size=10 x 10 m), that span across one-year period covering the wet and dry season). We observed two major vegetation types (secondary forest and mangrove) in the studied areas. Additionally, we documented 107 species belonging to 90 genera and 40 families. Species diversity analysis indicated higher diversity, abundance, species richness and evenness in Ikorodu and Epe during the wet has a greater while high species diversity was observed in Badagry during the dry season. The Dahomey gap phenomenon have greater implication on the Badagry vegetation while the coastal nature of Epe and Badagry negatively influenced their vegetation structure. Analyses inferred that species diversity pattern in the studied area seem to be determined by seasonal changes alongside anthropogenic activities and as a environmental factors (rainfall, geomorphology and geology). Further, our result suggests that Ikorodu could be regarded potential biodiversity hotspot area for conservation purposes because of its high floral composition and diversity. Therefore, improved management and conservation of the vegetation of the Ikorodu area is hereby recommended. The findings from this study will be useful in guiding the Physical Planning and Urban Development and Environment ministries in Lagos state for appropriate management and monitoring of developmental projects for sustainable development.
Keywords: species diversity; seasonal changes; physical environment; anthropogenic activities; Lagos state.

Impacto de los cambios estacionales en la composición de la vegetación de algunas áreas seleccionadas en el estado de Lagos, Nigeria

Resumen. La rápida degradación de los humedales y la fragmentación del hábitat son amenazas importantes para la diversidad de especies y el paradigma ecológico en el estado de Lagos, Nigeria. Según nuestro conocimiento, ningún estudio empírico ha explorado los efectos de los cambios estacionales en los conjuntos de vegetación dentro de las principales ciudades del estado de Lagos. Para ello, llevamos a cabo un estudio que abarca las tres ciudades principales de Lagos: Badagry, Epe e Ikorodu. Las parcelas permanentes se establecieron al azar para la recopilación de datos mensuales (método de cuadrantes; tamaño=10 x 10 m) que abarcan un período de un año que abarca la temporada húmeda y seca). Observamos dos tipos principales de vegetación (bosque secundario y manglar) en el área estudiada. Adicionalmente, documentamos un total de 107 especies pertenecientes a 90 géneros y 40 familias. Los análisis de diversidad de especies indicaron mayor diversidad, abundancia, riqueza de especies y uniformidad en Ikorodu y Epe durante la estación húmeda, mientras que se observó una alta diversidad de especies en Badagry durante la estación seca. El fenómeno de la brecha de Dahomey tiene una mayor implicación en la vegetación de Badagry, mientras que la naturaleza costera de Epe y Badagry afectó negativamente la estructura de la vegetación. Los análisis deducen que el patrón de diversidad de especies en el área estudiada parece estar determinado por cambios estacionales junto con actividades antropogénicas y factores ambientales (precipitación pluvial, geomorfología y geología). Además, nuestro resultado sugiere que se podría considerar a Ikorodu como un 'punto de acceso' al área de biodiversidad potencial por su importancia para la conservación debido a su alta composición floral y diversidad. Por lo tanto, ofrecemos recomendaciones para una mejor gestión y conservación de estas áreas. Los hallazgos de nuestro resultado serán útiles para guiar a los ministerios de Planificación Física y Desarrollo Urbano y Medio Ambiente en el estado de Lagos para la gestión adecuada y el monitoreo de proyectos de desarrollo para el desarrollo sostenible.
Palabras clave: diversidad de especies; cambios estacionales; ambiente físico; actividades antropogénicas; estado de Lagos.

Introduction

The Convention on Wetlands of International Importance (also known as RAMSAR Convention; Ramsar, 1994), defines wetlands as areas temporarily or permanently, naturally or artificially dominated by marsh, peatland, fen or water that may either be brackish or salty, fresh, free flowing or static (Cowan, 1995). Wetlands play vital roles in controlling soil erosion, purifying water, attenuating flood, regulating stream flow and serving as

[1] Department of Botany, University of Lagos, Akoka, Yaba, Lagos. 10213-Akoka, Nigeria.
Email: p1adeonipekun@yahoo.com; oyebanjioyetola@gmail.com; adebayomichael4@gmail.com

water reservoir, recreational and tourist centre among many other uses (Williams, 1990). Thus, the importance of wetland conservation and management cannot be over emphasized.

Biodiversity conservation scheme at any scale (local or region) is imperative to protect the ecological component in the environment and sustaining the benefits derived from them (Kotze, 1996). Over the years, vegetation/ecosystem conservation has become a global concern with special attention on wetlands (including Africa) because it serves as hotspot for biodiversity and have been experiencing degradation through anthropogenic activities.

African wetland is divided into three major geographic areas (Western, Southern and Eastern Africa; Denny, 1993) and five vegetation types (forests [swamp and riparian], grasslands, herbaceous, halophytic and mangroves wetlands; White, 1983) with diverse species composition characteristics. For instance, few dominant plant genera in forest wetland are: *Acacia* spp., *Anthocleista* spp., *Diospyros* spp., *Ficus* spp., *Hallea stipulosa, Raphia* spp., *Sarcocephalus* spp., and *Symphonia* spp.; grasslands (*Cyperus*, *Brachiaria, Echinochloa, Oryza, Phragmites, Typha* and *Vossia*); herbaceous (*Azolla*, *Ceratophyllum, Eichhornia, Lemna, Nymphaea, Pistia*, *Potamogeton, Wolffiopsis,* and *Salvinia*); halophytic (*Najas, Juncus, Diplachne,* and *Sporobolus*) and mangrove (*Avicennia*, *Laguncularia, Lumnitzera, Rhizophora,* and *Sonneratia)*.

Nigeria, the largest in West Africa, has an array of different vegetation types with an extensive wetland distribution in the South-Western zones particularly Lagos State. Different from the natural wetlands, are artificial wetland consequent to creation of ponds and dams with limited species diversity studies (Zakari, 1992; Eni *et al.,* 2011; Olubode *et al.,* 2011). Lagos is characterized by coastal environment (sandy barrier beaches, low-lying tidal flats, and estuaries) with three vegetation types (Mangrove, Secondary Rain Forest and Freshwater Swamp). Hitherto, the vegetation is still under constant threat with major causes of biodiversity loss being indiscriminate land reclamation for development (urbanization) and anthropogenic functions. (Dixon & Sherman, 1991, Filmer and Pritchett, 2002; Oramah, 2006; Pascual & Barbier, 2006). Abegunde (1988) reported that subcomponents of urbanization such as sand filling of lagoon shores, excessive dredging, extensive reclamation of wetlands, encroachment on natural drainage channel and unrestrained deforestation, have become frequent activities that characterize Lagos State. Unfortunately, this has been the case in the last three decades and its impact on Lagos vegetation cannot be overemphasized. Just as in many coastal cities around the globe, a full grasp of the effect of anthropogenic factors on coastal vegetation is yet to be properly assessed and quantified.

Ecologists and environmental scientists have expressed more concerns on the post effect(s) of rapidly disappearing vegetation rather than vegetation analysis which may provide a clue to the causes of plant diversity loss. However, past limited studies available include Adekanmbi & Ogundipe (2009); Obiefuna *et al.* (2013), Oladele (2013), Adeniyi *et al*., (2016), Akinsoji *et al.* (2016) and Adeleye *et al.,* (2017). Intriguingly, they all agreed that the vegetation was highly diverse but is under serious threat (Obiefuna *et al.*, 2013; Oladele, 2013; Adeniyi *et al*., 2016). Nonetheless, we assumed that lack of empirical studies to investigate seasonal fluctuations on species diversity pattern in Lagos state could be due to (i) conflicting representation of seasonal changes in aquatic and dry land ecosystems and (ii) development of effective evaluation methods. As much as we know, previous studies on Lagos vegetation have focused on either the floral diversity of selected study sites or changes in the vegetation size, with no record on the effect of seasonal changes. In support of this study, Rosenzweig (1995) had suggested the need to investigate seasonal patterns of diversity in other to understand the dynamics of plant communities. Asynchrony in species diversity fluctuations is also key for ecosystem stability. Furthermore, a detailed assessment of wetland biotopes including their location, ecological characteristics, and distribution are essential factors suggested for proper conservation and implementation strategies (Cilliers *et al*., 1998).

Thus, this study aims at evaluating the changes in floristic compositions of different ecosystems (mangrove, fresh water swamp forest, coastline vegetation, and secondary forest) across Lagos state vegetation zones (Badagry, Epe and Ikorodu) over a seasonality gradient. Accordingly, we provided information on the conservation status and habits of all encountered species. Finally, we offered recommendations for improved conservation of plant community under sustainable development in the region.

Materials and Methods

Study Area

Lagos is geographically located in South Western Nigeria between longitudes 2º 42' E to 3º 42' E and latitudes 6º 22' N to 6º 42' N, with two distinct seasons (Ogundele, 2012); wet (April to July, October and November) and dry (August and September; December to March). Wind directions depends on the Inter Tropical Convergence Zone (ITCZ) seasonal positions. Additional environmental parameters include: Mean annual rainfall (1381.7 mm–2733.4 mm), temperature (maximum [29ºC and 34ºC] and minimum [24ºC and 28ºC]) and high relative humidity (> 70%) throughout the year (Ogundele, 2012). Sequel to the reconnaissance survey conducted prior to this study, we divided Lagos state into three zones (Badagry, Epe and Ikorodu) based on vegetation richness and ecosystem diversity (Figure 1). These areas are representatives of Lagos state vegetation zones which are experiencing rapid degradation due to development and anthropogenic activities e.g. farming, constructions, infrastructure installations, habitat fragmentation and land fillings.

Vegetation analysis

Georeferenced conserved permanent plots in each location were randomly located based on accessibility and less anthropogenic interference (Table 1, Figure 1). These sampled points were analysed using quadrat method (size=10 x 10 m; Song & Zhang, 2013; Vinchesi &Walsh, 2014). Our data gathering lasted over a a period of one year (September, 2016 to August, 2017) which spanned dry season (DS) and wet season (WS). These sampling points were visited monthly to observe the changes in the vegetation composition and distribution. Plant species were identified to species level using the following literatures: Angiosperm Phylogeny Group (2009), Hutchinson & Dalziel, (1954; 1958, 1963, 1968 and 1972) and Akobundu & Agyakwa (1998). Specimens with uncertain taxonomy were collected and preserved following the method of Blanco *et al.* (2006). Subsequently, they were taken to the Herbarium, Department of Botany, University of Lagos for identification. Further, we assessed the conservation status of the encountered species using International Union for Conservation of Nature red list web- interface (IUCN ver. Olowokudejo & Oyebanji 2016; Oyebanji *et al*., 2017).

Data analyses

Primary data (observational records) collected analysis during our survey were used for the diversity analyses. Frequency distribution and relative frequency of occurrence location were calculated for each species based on locations and season (Appendix 1-3). Our diversity index analysis (Dominance, Evenness, Equitability, Shannon-wiener and Simpson's indices) were conducted using Palaeontological Statistics (PAST) software (v 2.17c, Hammer *et al*., 2001). Also, our study presented percentage plant family (APG, 2009) and habit (Life-form) distribution (Adeniyi *et al*., 2016; Walker *et al*., 2016). We evaluated similarities and differences among the selected studied sites using Jaccard correlation (statistical function in PAST software) based on species occurrence during the study.

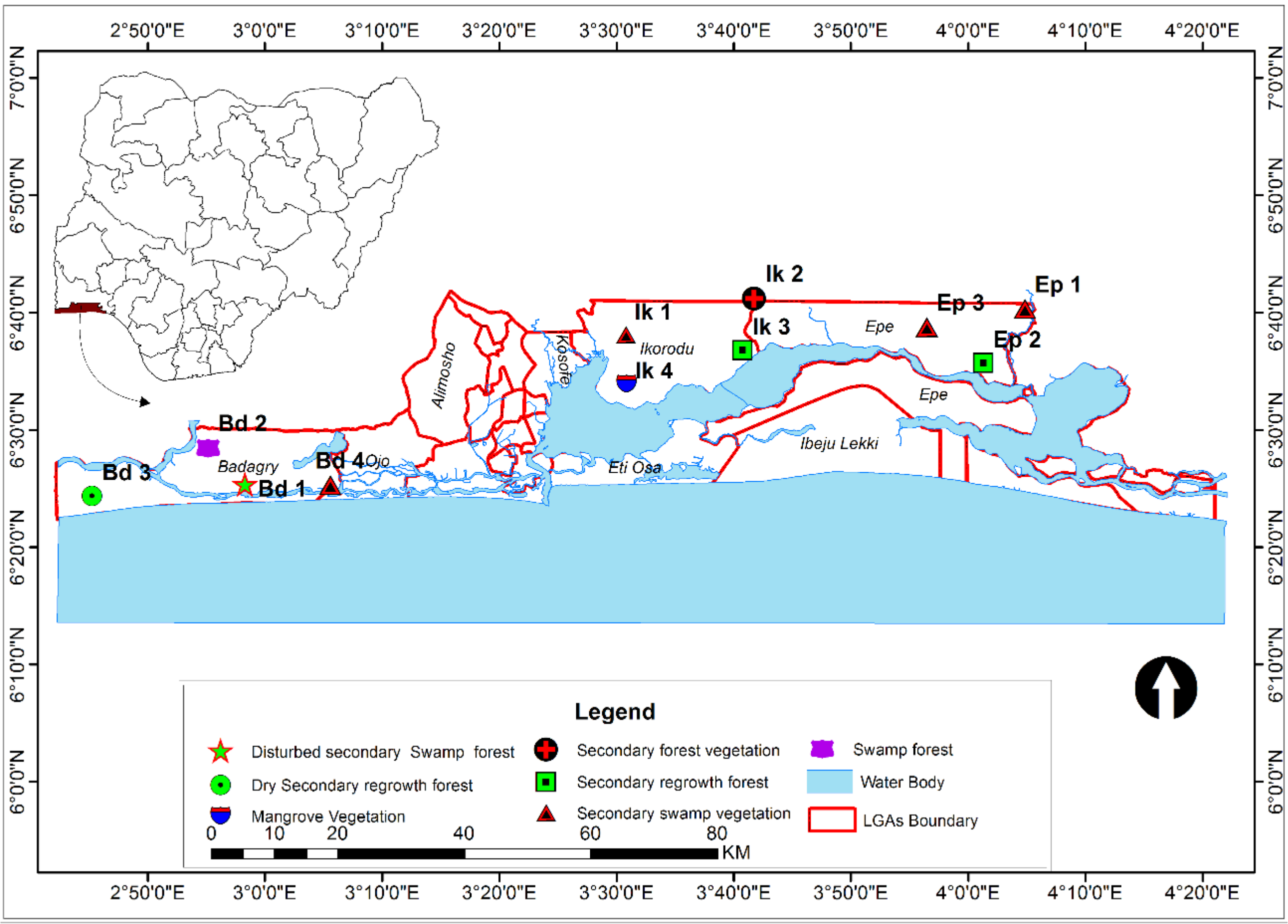

Figure 1. Map showing the selected study areas and respective sampling points within Lagos, Nigeria.

Table 1. Locality information showing the geographic coordinates and habitats

Location	Coordinates		Habitat
	Longitude	Latitudes	
BADAGRY 1	3^0 4.359’ E	6^0 29.973’ N	Disturbed secondary Swamp forest
BADAGRY 2	3^0 1.502’ E	6^0 28.846’ N	Swamp forest
BADAGRY 3	3^0 50.027’E	6^0 25.798’ N	Dry Secondary regrowth forest
BADAGRY 4	3^0 61.625’ E	6^0 26.751’ N	Swamp secondary forest
EPE 1	3^0 53.464’ E	6^0 30.770’ N	Swamp secondary forest
EPE 2	3^0 53.922’ E	6^0 32.173’ N	Secondary regrowth forest
EPE 3	3^0 55.466’ E	6^0 37.565’ N	Swamp secondary forest
IKORODU 1	3^0 53.464’ E	6^0 30.770’ N	Secondary swamp vegetation
IKORODU 2	3^0 53.922’ E	6^0 32.173’ N	Secondary forest vegetation
IKORODU 3	3^0 55.466’ E	6^0 37.565’ N	Secondary regrowth forest
IKORODU 4	3^0 53.464’ E	6^0 30.770’ N	Mangrove Vegetation

Results and Discussion

Species account

A total of 107 species belonging to 90 genera and 40 families were documented during the study (Table 2). We recorded co-occurring species (e.g. *A. vogelii*, *A. gangetica*, *E. coccinea*, *L. abbysinica*, *P. maximum*, *P. foetida*, *S. cayenense*, and *T. pentadrum*) in our sampling localities (Badagry, Epe and Ikorodu, Table 2), two dominant families (Cyperaceae and Poaceae; ten species each, Figure 2A) and seven life-forms (Figure 2B): forbs (n=34 species [32%]), trees (n=21 species [20%]), shrub (n=16 species [15%]), climber (n=13 species [12%]), grasses and sedges (n=10 species [9%] each) while the least was fern (n=3 species [3%]). Our study recorded higher species diversity compared to previous study (Adeniyi *et al*., 2016) that documented 49 species. In addition, we observed relatively high plant habit distribution across the studied sites. This could be attributed to the fact that the sites were wetlands and indicated a good repository of biodiversity.

We observed seasonal differences in species composition and abundance across all study areas, moreover some plants (e.g. *Alchornea cordifolia*, *Aspilia africana*, *Chromolaena odorata*, *Cyrtospermum senegalense*, *Dryopteris*, *Ipomoea involucrata* and *Raphia hookeri*) were observed to be present in both seasons (Table 2). Season-specific species were recorded across the locations: Badagry (WS [*Triumffeta cordifolia*] and DS [*Zornia latifolia, Eleocharis* and *Hoslundia opposita*]), Epe (WS [*Axonopus compressus*] and DS [*Costus afer*, *Cyathula prostrata*, *Erigeron floribunda* and *Heteropteris Leona*]) and Ikorodu (WS [*Cissus aralioides, Clerodendrum polycephalum, Dioscorea alata, Ficus erybotryodes, Gomphrena celosioides, Holarhena floribunda* and *Indigofera arrecta*] and DS [*Sterculiar tragacantha*]). Our study recorded only one vulnerable species (VU; *Hallea stipulosa*, Rubiaceae) while the majority are either least concern (LC) or not evaluated (NE).

This finding suggests that seasonality plays little or no role in the distribution of ‘cosmopolitan’ plant species (i.e. species present in both DS and WS). Since geographical space did not limit their occurrence, we infer that shared environmental and climatic characteristics could be predominant factors that necessitated the co-occurrence of these species. Thus, these species may be described as Lagos vegetation cosmopolitan species. Moreover, these plants may not be abundantly recovered, they will always be present in any of the vegetation types in any location in Lagos state. Edaphic and topographic as well as climatic factors may have been responsible for the uneven distribution of these species. Although our findings showed that these species could be space controlled and not evenly distributed, yet, further studies are required to justify this fact across the entire geographic range of these species.

Vegetation description and Species diversity

Badagry location

We encountered two vegetation types (secondary swamp and dry secondary forest). A total of 55 species belonging to 48 genera and 27 families were documented (Table 1). Our study documented the dominant family (Cyperaceae,7 species) and species (*T. domingensis*) while most species were forbs (36%; Figure 3a, 3b). Furthermore, frequencies and relative frequency of species occurrence varied with the locations (Appendix 1). Our study showed that *A. cordifolia* occurred in all the sampling points within Badagry while *A. gangetica*, *C. diffusa* and *F. trichopoda* occurred in at least three of the sampling points in Badagry (Appendix 1).

Highest species diversity was observed in DS (n=51 species [56%]) compared to WS (n=40 species [44%]). Six species (*A. cordifolia, A. africana, A. gangetica, C. odorata, C. difformis* and *C. senegalense*) were recorded in both seasons while three species each were documented in WS (three species; *P. vaginatum, M. alternifolius* and *T. pentandra*) and DS (*A. aureum, C. mucunoides* and *N. biserrata*) respectively (Appendix 1).

Our finding correlated seasonal changes with species diversity in Badagry. Although differences in the percentage frequency of most species present in both seasons was little or rather negligible, however, several others have clear differences (e.g. *A. cordifolia* (WS [3.25%] and DS [12.65%]) and *L. abbysinica* WS [11.80%] and DS [3.02%]; Appendix 1).

Further, these factors are burning might have affected species distribution (abundance and diversity) in Badagry include burning, clearing, exploitation for medicinal purposes, extraction of non-forest timber products, farming, housing projects, fuel wood, transportation and sand filling. The observations are similar to results from past studies (Filmer & Pritchett, 2002; Oramah, 2006; Pascual & Barbier, 2006; Adeniyi *et al*., 2016; Olowokudejo & Oyebanji, 2016) on the influence of human factors on species diversity.

Table 2. Distribution and IUCN conservation status of encountered flora species during field survey. Abbreviation are: NE, Not evaluated; LC, Least concern; VU, Vulnerable; Cl, Climber; Gr, Grass; Tr, Tree; Fo, Forb; Fr, Fern; Se, Sedge; Sh, Shrub.

	Family	Species name	Habit	Badagry		Epe		Ikorodu		IUCN
				Wet	Dry	Wet	Dry	Wet	Dry	
1	Acanthaceae	*Asystasia gangetica* (L.) T. Anderson	Fo	√	√	–	√	√	√	NE
		Commelina diffusa Burm. f.	Fo	√	√	–	–	√	–	LC
2	Amaranthaceae	*Cyathula prostrata* (L.) Blume	Fo	–	–	–	√	–	–	NE
		Gomphrena celosioides Mart.	Fo	–	–	–	–	√	–	NE
3	Apocynaceae	*Alstonia boonei* De Wild.	Tr	–	–	√	√	√	√	NE
		Holarrhena floribunda (G.Don) T.Durand & Schinz	Tr	–	–	–	–	√	–	NE
		Landolphia dulcis (Sabine ex G.Don) Pichon	Cl	–	–	–	–	√	–	NE
		Rauvolfia vomitoria Afzel.	Tr	–	–	–	–	√	√	NE
4	Araceae	*Cyrtosperma senegalense* Schott Engl.	Fo	√	√	√	√	√	√	LC
		Elaeis guineensis Jacq.	Tr	√	√	√	√	–	–	LC
5	Arecaceae	*Phoenix reclinata* Jacq.	Tr	–	–	–	–	√	√	NE
		Raphia hookeri G.Mann & H.Wendl.	Tr	√	√	√	√	√	√	NE
		Raphia vinifera P. Beauv.	Tr	–	–	√	–	–	–	NE
6	Asteraceae	*Ageratum conyzoides* L.	Fo	–	–	–	√	–	–	NE
		Aspilia africana (Pers.) C. D. Adams	Fo	√	√	√	√	√	√	NE
		Chromolaena odorata (L.) R. King & H. Rob.	Fo	√	√	√	√	√	√	NE
		Emilia coccinea (Sims) G. Don	Fo	–	√	–	√	√	√	NE
		Erigeron floribundus (Kunth) Sch. Bip.	Fo	–	–	–	√	–	–	NE
		Mikania tomentosa (Lam.) Willd.	Cl	√	–	–	–	–	–	NE
		Vernonia cinerea (L.) Less.	Fo	–	√	–	–	–	√	NE
7	Caesalpinioideae	*Senna occidentalis* (L.)Link	Sh	√	√	–	–	–	–	NE
		Senna rotundifolia Pers.	Fo	–	–	√	–	–	–	NE
8	Connaraceae	*Brysocarpus coccineus* Shum. & Thonn.	Sh	–	–	–	–	√	√	NE
9	Convolvulaceae	*Ipomoea aquatica* Forssk.	Cl	√	√	–	–	–	–	LC
		Ipomoea involucrata Beauv.	Cl	√	√	√	√	√	√	NE
10	Costaceae	*Costus afer* Ker Gawl.	Sh	–	–	–	√	–	–	NE
11	Cucurbitaceae	*Lagenaria breviflora* (Benth.) Roberty	Cl	√	√	–	√	–	–	NE
12	Cyperaceae	*Cyperus articulata* L.	Se	√	√	–	–	√	√	NE
		Cyperus difformis L.	Se	–	–	–	–	–	√	LC
		Cyperus distans L.f.	Se	–	√	–	–	√	–	LC
		Cyperus iria L.	Se	–	–	–	–	√	√	LC
		Eleocharis cf. *geniculata* (L.) Roem. & Schult.	Se	–	√	–	–	–	–	LC
		Mariscus alternifolius Vahl	Se	√	–	–	√	–	–	NE
		Mariscus flabelliformis Kunth	Se	–	–	√	√	–	–	NE
		Pycreus sp. P. Beauv.	Se	–	√	–	–	–	–	
		Pycreus smithianus (Ridl.) C.B.Clarke	Se	√	√	–	–	–	–	NE
		Scleria depressa (C.B.Clarke) Nelmes	Se	√	√	√	√	–	–	NE
13	Davalliaceae	*Nephrolepis biserrata* (Sw.) Schott	Fr	–	√	–	–	√	–	NE
14	Dioscoreaceae	*Dioscorea alata* L.	Cl	–	–	–	–	√	–	NE
15	Dryopteridaceae	*Dryopteris marginalis* (L.) Gray	Fr	√	√	√	√	√	√	NE
16	Euphorbiaceae	*Alchornea cordifolia* Müll.Arg.	Sh	√	√	√	√	√	√	NE
		Caperonia palustris (L.) A.St.-Hil.	Fo	√	√	–	–	–	–	NE
		Maesobotrya barteri (Baill.) Hutch.	Tr	√	√	√	–	–	–	NE

	Family	Species name	Habit	Badagry		Epe		Ikorodu		IUCN
				Wet	Dry	Wet	Dry	Wet	Dry	
		Microdesmis puberula Hook.f. ex Planch.	Sh	–	–	–	–	√	–	NE
		Securinega virosa (Roxb. ex Willd.) Baill.	Sh	–	–	–	–	√	–	NE
		Spondianthus preussii Engl.	Sh	–	–	√	–	–	–	NE
17	Gentianaceae	*Anthocleista djalonensis* A. Chev.	Tr	–	–	√	–	–	–	NE
		Anthocleista vogelii Planch.	Tr	√	√	√	–	√	√	NE
18	Guttiferae	*Harungana madagascariensis* Poir.	Tr	–	–	–	–	√	√	NE
19	Lamiaceae	*Hoslundia opposita* Vahl	Sh	–	√	–	–	–	–	NE
		Solenostemon monostachyus (P.Beauv.) Briq.	Fo	√	√	–	√	–	–	NE
20	Malphigiaceae	*Heteropterys leona* (Cav.) Exell	Sh	–	–	–	√	–	–	NE
21	Malvaceae	*Sida acuta* Burm. fil.	Fo	–	–	√	–	√	√	NE
		Urena lobata L.	Fo	–	–	√	–	–	–	NE
22	Melastomataceae	*Dissotis rotundifolia* (Smith) Triana	Fo	–	–	√	√	√	√	NE
23	Mimosoideae	*Mimosa pudica* L.	Fo	–	–	–	–	√	–	LC
24	Moraceae	*Ficus eriobotryoides* Kunth & Bouche	Tr	–	–	–	–	√	–	NE
		Ficus sp. L	Tr	√	√	–	–	√	–	
		Ficus sur Forssk.	Tr	–	–	–	√	–	√	NE
		Ficus trichopoda Bak.	Tr	√	√	√	–	–	–	NE
		Musanga cecropioides R. Br. apud Tedlie	Tr	–	–	–	–	√	–	NE
25	Onagraceae	*Ludwigia abyssinica* A. Rich.	Fo	√	√	–	√	√	√	NE
26	Papilionoideae	*Calopogonium mucunoides* Desv.	Cl	–	√	–	√	√	–	NE
		Centrosema pubescens Benth.	Cl	√	√	–	–	√	√	NE
		Desmodium ramosissimum G.Don	Fo	–	–	√	√	√	–	NE
		Desmodium tortuosum (Sw.) DC.	Fo	–	–	√	–	–	–	NE
		Desmodium triflorum (L.) DC.	Fo	–	–	√	√	–	–	LC
		Drepanocarpus lunatus (L.f.)G.Mey.	Sh	–	–	–	–	√	√	NE
		Indigofera arrecta A.Rich.	Fo	–	–	–	–	√	–	NE
		Mucuna pruriens (L.)DC.	Cl	√	√	–	–	–	–	NE
		Zornia latifolia Sm.	Fo	–	√	–	–	–	–	NE
27	Passifloraceae	*Passiflora foetida* L.	Cl	√	√	√	√	√	–	NE
28	Phyllanthaceae	*Phyllanthus muellerianus* (Kuntze) Exell	Sh	–	–	–	–	√	√	NE
29	Poaceae	*Axonopus compressus* (Sw.) P. Beauv.	Gr	–	–	√	–	–	–	NE
		Brachiaria deflexa (Schumach.) C.E.Hubb. ex Robyns	Gr	–	–	–	√	√	–	NE
		Digitaria horizontalis Willd.	Gr	–	–	√	√	–	√	NE
		Oplismenus burmannii (Retz.) P.Beauv.	Gr	–	√	–	–	√	–	NE
		Panicum maximum Jacq.	Gr	√	√	√	–	√	√	NE
		Paspalum sp. L.	Gr	–	√	–	–	–	–	
		Paspalum vaginatum	Gr	√	√	–	–	√	√	LC
		Pennisetum sp. Rich.	Gr	–	–	–	–	√	–	
		Sacciolepis africana C. E. Hubb. & Snowden	Gr	√	√	√	√	–	–	NE
		Sporobolus pyramidalis P.Beauv.	Gr	–	–	√	–	√	√	NE
30	Pteridaceae	*Acrostichum aureum* L.	Fr	–	√	–	–	√	√	LC
31	Rhizophoraceae	*Rhizophora racemosa* G. Mey.	Tr	–	–	–	–	√	√	LC
32	Rubiaceae	*Hallea stipulosa* (DC.) Leroy	Tr	–	–	√	√	–	–	VU
		Morinda morindoides (Baker) Milne-Redh.	Sh	–	–	–	–	√	√	NE
		Mussaenda polita Hiern	Sh	√	√	–	–	√	–	NE
		Pentodon pentandrus (Schumach. & Thonn.) Vatke	Fo	√	√	√	√	–	–	LC
		Psychotria sp. L.	Sh	–	–	√	–	–	–	

	Family	Species name	Habit	Badagry		Epe		Ikorodu		IUCN
				Wet	Dry	Wet	Dry	Wet	Dry	
		Spermacoce ocymoides Burm.f.	Fo	–	–	–	–	√	–	NE
		Spermacoce ruelliae DC.	Fo	√	–	–	–	√	–	NE
		Zanthoxylum zanthoxyloides (Lam.)B. Zepernick & F.K.	Tr	√	√	–	–	–	–	NE
33	Sapindaceae	*Allophylus africanus* P. Beauv.	Sh	–	–	–	–	√	–	NE
34	Scrophulariaceae	*Scoparia dulcis* L.	Fo	–	√	–	√	–	–	NE
35	Smilacaceae	*Smilax anceps* Willd.	Cl	–	–	√	–	√	–	NE
36	Sterculiaceae	*Sterculia tragacantha* Lindl.	Tr	–	–	–	–	–	√	NE
		Waltheria indica L.	Fo	√	√	–	–	–	–	NE
37	Tiliaceae	*Triumfetta cordifolia* A. Rich.	Fo	√	√	√	–	√	–	NE
		Triumfetta pentandra A. Rich. ex Guill. & Perr.	Fo	√	–	–	–	–	–	NE
38	Typhaceae	*Typha domingensis* Pers.	Fo	√	√	–	–	√	√	LC
39	Verbenaceae	*Clerodendrum polycephalum* Bak.	Sh	–	–	–	–	√	–	NE
		Stachytarpheta cayennensis (Rich.) Vahl	Fo	–	√	√	√	√	√	NE
		Stachytarpheta jamaicensis (L.) Vahl	Fo	-	√	-	-	√	√	NE
		Vitex grandifolia Gürke	Tr	–	–	–	–	√	–	NE
40	Vitaceae	*Cissus aralioides* (Welw. ex Bak.) Planch.	Cl	–	–	–	–	√	–	NE
		Cissus sp. L.	Cl	√	√	√	√	–	–	NE

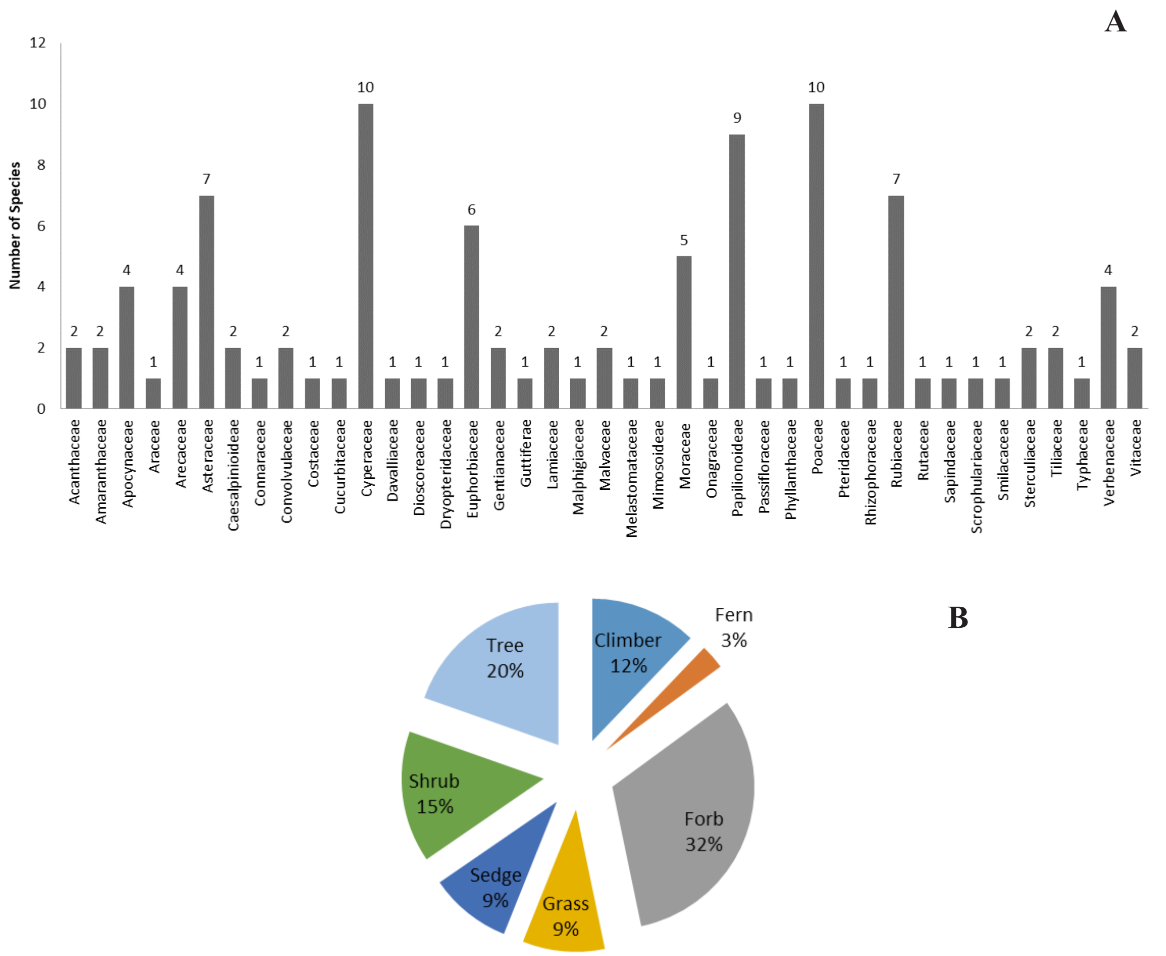

Figure 2. Distribution of species across all studied areas during the sampling period.

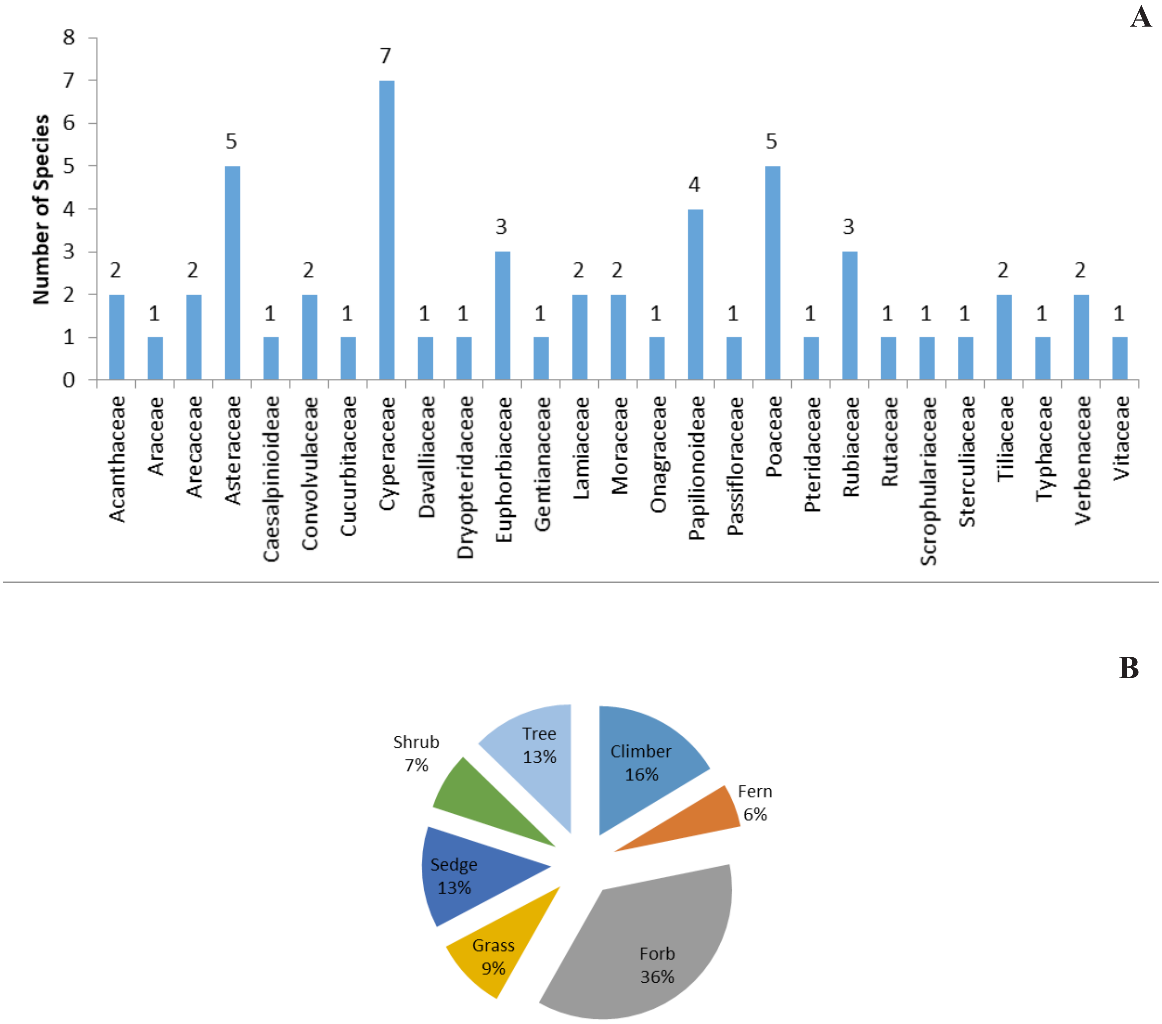

Figure 3. Distribution of species in Badagry, Lagos state, Nigeria. A: Family distribution; B: Percentage distribution of Plant life-forms.

Epe location

Similarly, we identified two vegetation types (freshwater swamp secondary and dry secondary forest), and a total of 52 species, belonging to 46 genera and 29 families (Table 1). The dominant family was Poaceae (six spp.), *Desmodium*, the most common species (three species) while most of the species were forbs (n=21 spp. [40%]; Table 3, Figure 4A, 4B). Only one species (*A. cordifolia*) occurred in all the sampling points while three species (C. afer, D. tortuosum, and *E. coccinea*) were restricted to one sampling point (Appendix 2).

Freshwater aquatic species recorded in this area were *N. lotus, S. natans, C. dermasum, E. crassipes* and *P.stratiotes*, although they were found outside the studied quadrats. Previous studies of Okorie (2012) have described mosaic vegetation types in Epe to include freshwater Swamp Forest. Adeniyi et al. (2016) also documented these species but they did not capture C. dermasum (submerged species) which is recorded in this study.

Species diversity was slightly higher in WS (n=37 species [51%]) than DS (n=36 species [49%]). In contrast, we observed variations in species distribution as season changes; WS – [*A. compressus, F. trichopoda,* and *T. pentandrus*], DS [*L. abbysinica, M. alternifolius,* and *S. dulcis*]) while four species (*A. cordifolia, A. boonei, A. africana,* and *C. odorata* were recorded for both seasons (Appendix 2). However, we reported dominant species in WS (*R. vinifera* and *S.africana*) and DS (*A. cordifolia*, *P. pentandrus,*and *S. africana*) respectively.

Clearing and sand filling of swamp dominated by *Raphia* spp., farming, road construction, extraction of non-forest timber products, indiscriminate burning, and fuel wood are some of the anthropogenic factors observed in Epe during our field survey. These activities have been reported to profoundly affect species distribution, abundance and diversity. Previous study (Okorie, 2012) had attributed vegetation loss in Epe to anthropogenic factors such as deforestation (majorly felling of wood for industrial purposes and agriculture), and urban development. On the other hand, Obiefuna *et al*. (2013) attributed the decrease (85.5% & 44%) in area covered swamp and mangrove in Epe between 1984 and 2006 to human activities. In a study of wetland areas of Ibeju/Lekki (closely located near Epe) in Lagos state, Adeniyi *et al.* (2016) reported the alarming rate of wetlands degradation (decreasing wetland floral diversity) consequent to anthropogenic factors owing to industrialization (e.g. construction of Lekki Port and Lekki Free Trade Zone). Given that the Lekki/Ajah axis has begun to experience development upsurge, attention for land use extends rapidly into the Epe areas. As a result of the negative effects of human activities on plant communities, there is need for necessary ameliorative and management plans as well as strategies to properly guide urbanization in Epe environs.

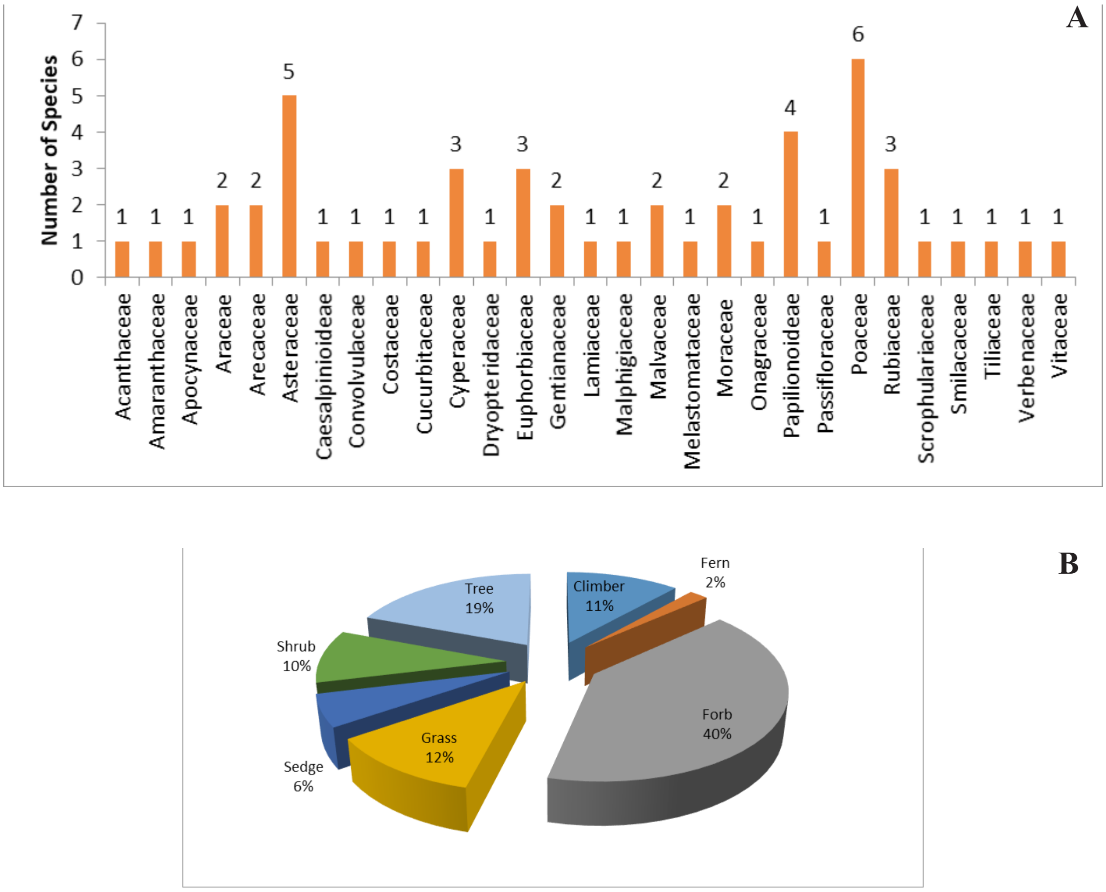

Figure 4. Distribution of species in Epe, Lagos state, Nigeria.
A: Family distribution; B: Percentage distribution of Plant life-forms.

Ikorodu location

The sampled vegetation types comprised secondary (dry and swamp forest) and mangrove forest (Table 1). Ikorodu recorded the highest diversity (66 species, 59 genera in 34 families) compared to Epe and Badagry regions. The dominant family was Cyperaceae, (seven spp.) while most species were forbs (n=20 species [30%], Figure 5A, 5B). Our study recorded four mangrove species (*A. aureum, D. lunatus R. racemosa* and *P. reclinata*) and long stretch of *R. hookeri* along the wetland/swamp that extends across Ikorodu sampling point 3 (Table 1).

Species diversity was higher in WS (n=61 species [62%]) than in the DS (n=37 species [38%]). *Panicum maximum* is the most dominant species while *A. cordifolia* and *C. odorata* are dominant in WS and DS respectively (Appendix 3).

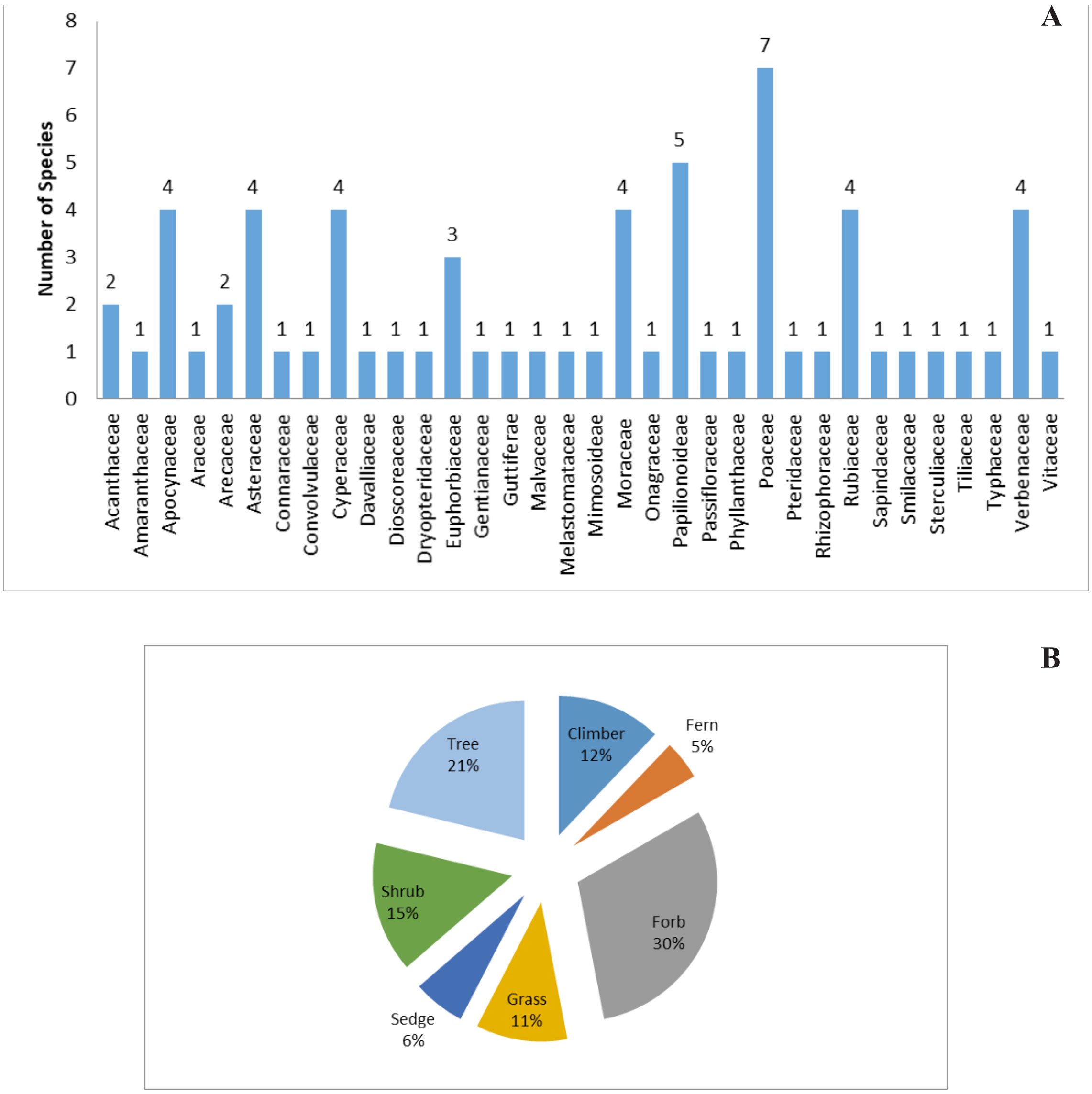

Figure 5. Distribution of species in Ikorodu, Lagos state, Nigeria. A: Family distribution; B: Percentage distribution of Plant life-forms.

Study Area comparison

Seasonal difference in the occurrence of taxa

Results from this study showed that the occurrence of most taxa varied with seasons in all the studied locations, as evidenced by: (a) difference in species diversity and evenness in dry and wet seasons (b) varying species number, individuals and equitability (c) differential values of species abundance and frequencies on both seasons. Observations made regarding the differences in species abundance, diversity, evenness and equitability with respect to season is consistent with the study of Cruz-García (2015). Comparing the seasonal occurrence of taxa in the three sampling locations, the highest species diversity (n=61) was recorded in Ikorodu during the DS while least species number (n=36) was recorded in Epe during the DS. In contrast, Badagry, had high species diversity and the abundance during the WS (Table 3). Generally, species diversity pattern observed fluctuates with seasonal changes (WS, high diversity and DS, low diversity). Previous study of Shimadzu *et al.* (2013) showed that rainfall is a strong environmental factor that determines the response of species and therefore dictates the seasonal changes in species' abundance.

This effect was evident in our study although with exceptions e.g. *A. cordifolia* and *S. africana* which increased during the DS but reduced drastically during the WS in Badagry. Similar observation was made in Epe (*A. cordifolia*, *P. pentandrus,* and *P. foetida*) and Ikorodu (*S. acuta*, *P. maximum*, and *B. coccineus*). Despite these evidential changes in species abundance over a seasonal gradient, we observed that some species were available and abundant all-round the study period suggesting that their abundance were not affected by the temporal changes. For instance, in Badagry, *C. odorata, T. domingensis,* and *R. hookeri* were analysis present in both seasons (Figure 6).

Our species diversity index analyses (Table 3) revealed high diversity in two locations (Epe and Ikorodu) during the WS and one location (Badagry) in DS. The highest species abundance was recorded during the WS in Ikorodu compared to other localities (Table 3).

Williams *et al.* (2008) demonstrated that rainfall is the most significant variable among within-year climatic variability that determines vegetation spatial pattern. This shows that the abundance, distribution and plant assemblages/diversities in tropics is predominantly determined by rainfall. This result somewhat supported the general expectation of higher species occurrence in the WS (Epe and Ikorodu). This therefore suggests that anthropogenic factors, more than the physical environment, played a vital role in determining seasonal taxa occurrences and species diversity in these locations (Cruz-García, 2015).

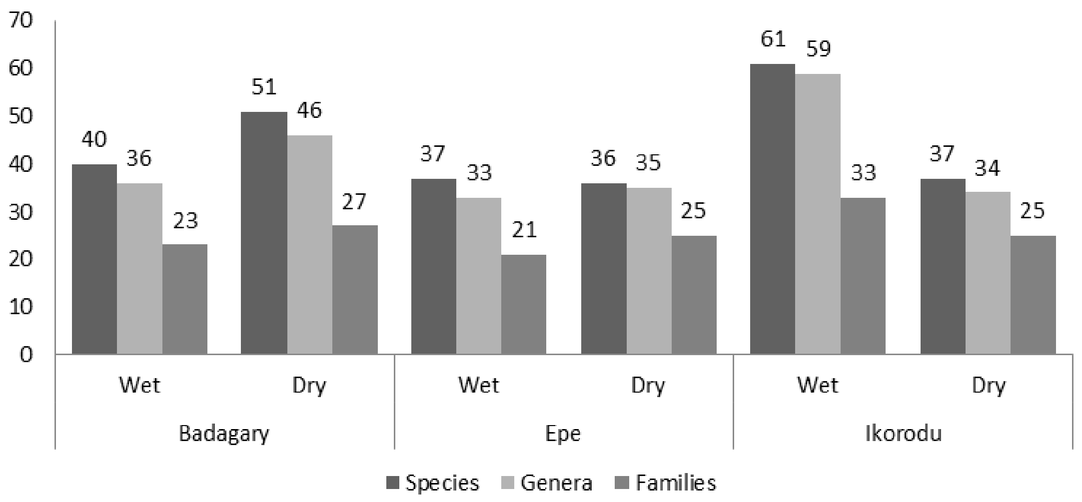

Figure 6. Taxonomic classification of species encountered in Badagry, Epe and Ikorodu areas of Lagos.

Table 3. Diversity analyses of floral species encountered in each sampling locations during dry and wet seasons.

	BADAGRY		EPE		IKORODU	
	WET	DRY	WET	DRY	WET	DRY
Taxa_S	40	51	37	36	61	37
Dominance_D	0.025	0.0196	0.0270	0.0278	0.04164	0.0270
Simpson_1-D	0.9178	0.9231	0.973	0.972	0.984	0.973
Shannon_H	3.689	3.932	3.611	3.584	4.111	3.611

Species Diversity and Species Evenness

Deane *et al.* (2016) remarked that wetlands are useful reservoirs of plant diversity. In the studied wetland areas, species diversities (Table 4) was the generally high, particularly in Ikorodu. Interestingly, our field survey showed that Ikorodu vegetation areas was most disturbed region compared to other study area. This region was often characterized by sand filling, housing projects, industrialization, road construction and farming. Despite this, we recorded impressive floristic composition. Our result therefore indicate that Ikorodu is an area of conservation importance.

The species evenness was observed to be high across all the studied localities, but highest in Epe (0.9365) than Badagry (0.9017) and Ikorodu (0.925). There was a direct relationship between taxa occurrence, species diversity and species evenness across the studied areas (Table 4). The area with relatively high number of species (Ikorodu) was observed to be more diverse and its representative species were more evenly distributed. This may be attributed to the size of the species pool (Silva *et al.*, 2010).

A reduction in population size usually results from the effect of environmental constraints such as waterlogging and drought which leads to decrease in species abundance, infer diversity and availability (Tokeshi, 1999). Thus, we inferred that the proximity of Epe and Badagry to the Lagoon coupled with occasional incidence of waterlogging might have resulted in the decrease in the number, abundance and diversity of species encountered. Notwithstanding, our results may indicate that most individuals in these locations are flood resistant (Table 1).

Table 4. Species diversity indices of Ikorodu, Epe and Badagry in Lagos State.

	Ikorodu	Epe	Badagry
Taxa_S	66	52	55
Individuals	80	71	78
Dominance_D	0.01875	0.02123	0.02301
Simpson_1-D	0.9812	0.9788	0.977
Shannon_H	4.081	3.923	3.886
Evenness_e^H/S	0.925	0.9365	0.9017
Equitability_J	0.9812	0.9836	0.9741

Ecosystem Similarity

Our ecosystem correlation analysis (Jaccard correlation, dendogram), classified the sampling points into two main ecosystem groups (A [secondary forest] and B [mangrove vegetation]; Figure 7).

Group A depicting a secondary forest species comprised of individuals from Ikorodu (1-3); Badagry (2-3), and Epe (1-3). Furthermore, group A was subdivided into three subgroups: subgroup1 included populations from dry secondary forest ecosystem (Badagry 3, Epe 2, Ikorodu 2 & 3), subgroup 2 consisted of individuals from fresh water swamp forest ecosystem (Badagry 1 & 2, Epe 1and Ikorodu 1) while subgroup 3 comprised of individuals from mosaic of dry and swamp ecosystem (Epe 3). Moreover, most similar locations were (Badagry 2 and Epe 1 =0.34) followed by Epe 2 and Ikorodu 2 having Jaccard similarity index value of and 0.26.

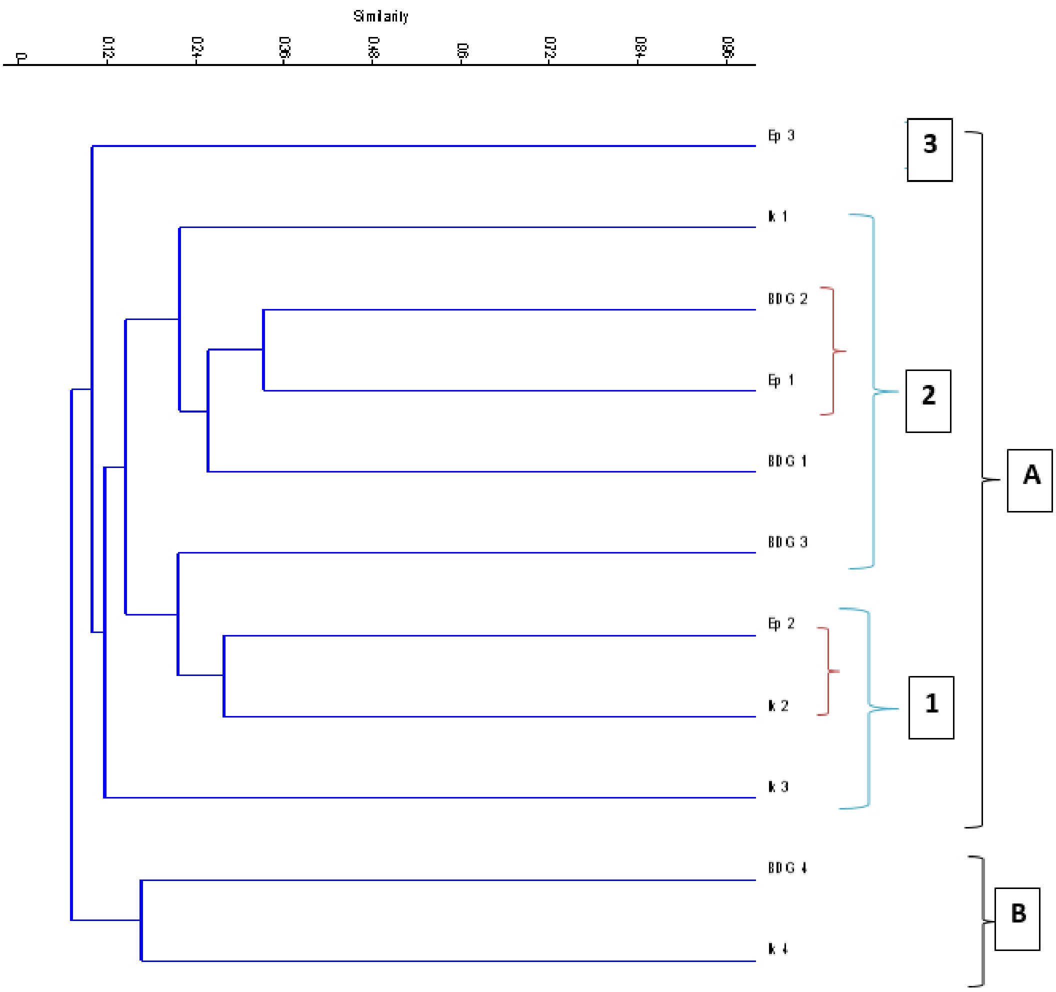

Figure 7. Jaccard Correlation (dendogram) showing the similarities among the sampled locations. A: Secondary forest ecosystem (Number in boxes indicates mosaic vegetations: 1, dry secondary forest ecosystem; 2, fresh water swamp forest; 3, dry and swamp forest); B: Mangrove ecosystem; BDG, Badagry (1-4), Ep, Epe (1-3), and IK–Ikorodu (1-4).

Group B which included individuals from mangrove vegetation were collected from Badagry 4 and Ikorodu 4 (similarity index value=0.16). Although, Badagry 4 is not entirely mangrove ecosystem, the presence of mangrove species (*A. aureum*) necessitated its classification as mangrove ecosystem. This occurrence has been attributed to be vestiges of a once flourishing mangrove ecosystem in the Holocene (Sowunmi, 2004) which has now been replaced by freshwater elements.

Finally, we infer that the effect of seasonality on species abundance and diversity as seen in all locations could be due to conflicting processes such as primary and secondary succession (Zhang *et al.*, 2012), climaxing (White, 1979) and invasion (Grice, 2006) within the plant community which ultimately contributed to species variability in terms of abundance and diversity. Other probable reasons include availability of resources, environmental conditions, species interaction (interspecific and intraspecific competition; Oladele, 2013), demographic stochasticity (Shimadzu *et al.*, 2013) and anthropogenic activities (Shaheen *et al.*, 2011).

Conservation status

Our study classified the species encountered into three conservation categories (according to IUCN, Table 1): NE (92 spp.), LC (14 spp.) and VU (one spp.). Documentation of *H. stipulosa* (vulnerable species, IUCN version 2.3) is novelty in this study. However, we recommend further ecological studies to ascertain current conservation status of these species especially *H. stipulosa*. The occurrence of conservation concern species such as the above-mentioned *H. stipulosa* and the increasing of anthropogenic factors justified the current rating (potentially threatened) proposed in this study.

Conclusion and recommendation

The impact of climate change on floral diversity is presumed to be largely due to changes in rainfall and temperature pattern, which consequently, resulted in variations in nutrient cycles, microbial and physiological activities in plants. We observed different species diversity within the locations even though they activities shared similar climatic conditions and anthropogenic although at different intensity. Our study revealed that recent development and urbanization project would have devastating effects on the plant community and may probably reduce wetland cover in the region. On this premise, we recommend that, (i) Ministry of Environments should map out the Ikorodu – Epe axis for conservation purposes, (ii) adopt strict monitoring policy and wetland conservation programmes (iii) conduct regular vegetation assessment and (iv) integrate biodiversity conservation into state development plans (sustainable development).

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Appendix 1. Percentage seasonal frequency distribution and species occurrence in Badagry, Lagos State. Abbreviations are: Keys: FOC, Frequency of Occurrence; RFOC, Relative Frequency of Occurrence; Cl, Climber; Gr, Grass; Tr, Tree; Fo, Forb; Fr, Fern; Se, Sedge; Sh, Shrub.

S/N	Species	Family	Habit	Wet (%)	Dry (%)	FOC	RFOC (%)
1.	*Asystasia gangetica*	Acanthaceae	Fo	3.05	2.09	3	75
2.	*Commelina diffusa*	Acanthaceae	Fo	1.22	0.70	3	75
3.	*Cyrtosperma senegalense*	Araceae	Fo	0.81	1.16	1	25
4.	*Elaeis guineensis*	Arecaceae	Tr	0.20	0.81	2	50
5.	*Raphia hookeri*	Arecaceae	Tr	0.20	0.46	2	50
6.	*Aspilia africana*	Asteraceae	Fo	2.03	0.46	2	50
7.	*Chromolaena odorata*	Asteraceae	Fo	10.16	8.00	2	50
8.	*Emilia coccinea*	Asteraceae	Fo	0	1.16	1	25
9.	*Vernonia cinerea*	Asteraceae	Fo	0	0.93	2	50
10.	*Senna occidentalis*	Caesalpinioideae	Sh	0.41	0.23	1	25
11.	*Ipomoea aquatica*	Concolvulaceae	Cl	1.02	0.70	1	25
12.	*Ipomoea involucrata*	Convolvulaceae	Cl	1.02	2.90	1	25
13.	*Lagenaria breviflora*	Cucurbitaceae	Cl	0.41	0.23	1	25
14.	*Cyperus articulatus*	Cyperaceae	Se	8.13	6.38	1	25
15.	*Cyperus distans*	Cyperaceae	Se	0	0.23	1	25
16.	*Cyperus difformis*	Cyperaceae	Se	0.61	0.46	1	25
17.	*Eleocharis* cf. *geniculata*	Cyperaceae	Se	0	0.23	1	25
18.	*Mariscus alternifolius*	Cyperaceae	Se	0.61	0	1	25
19.	*Mikania tomentosa*	Cyperaceae	Se	0.41	0	1	25
20.	*Pycreus smeathianus*	Cyperaceae	Se	0	1.16	1	25
21.	*Scleria depressa*	Cyperaceae	Se	0.20	0.35	1	25
22.	*Dryopteris marginalis*	Davalliaceae	Fr	15.24	15.66	2	50
23.	*Nephrolepis biserrata*	Davalliaceae	Fr	0	0.58	1	25
24.	*Alchornea cordifolia*	Euphorbiaceae	Sh	3.25	12.65	4	100
25.	*Caperonia palustris*	Euphorbiaceae	Fo	1.02	0.23	1	25
26.	*Maesobotrya barteri*	Euphorbiaceae	Tr	0.20	0.23	1	25
27.	*Anthocleista vogelii*	Gentianaceae	Tr	1.02	2.55	3	75
28.	*Hoslundia opposita*	Lamiaceae	Sh	0	0.23	1	25
29.	*Solenostemon monostachyus*	Lamiaceae	Fo	0.81	0.12	2	50
30.	*Ficus* sp.	Moraceae	Tr	0.20	0.23	1	25
31.	*Ficus trichopoda*	Moraceae	Tr	0.20	0.81	3	75
32.	*Ludwigia abbysinica*	Onagraceae	Fo	11.18	3.02	2	50
33.	*Calopogonium mucunoides*	Papilionoideae	Cl	0	0.23	1	25
34.	*Centrosema pubscens*	Papilionoideae	Cl	1.22	0.35	1	25
35.	*Mucuna pruriens*	Papilionoideae	Cl	2.03	0.46	1	25
36.	*Zornia latifolia*	Papilionoideae	Fo	0	0.12	1	25
37.	*Passiflora foetida*	Passifloraceae	Cl	0.81	0.35	2	50
38.	*Oplismenus burmannii*	Poaceae	Gr	0	2.32	1	25
39.	*Panicum maximum*	Poaceae	Gr	0.20	3.25	2	50

S/N	Species	Family	Habit	Wet (%)	Dry (%)	FOC	RFOC (%)
40.	*Paspalum* sp.	Poaceae	Gr	0	4.64	1	25
41.	*Paspalum vaginatum*	Poaceae	Gr	6.10	0	1	25
42.	*Sacciolepis africana*	Poaceae	Gr	5.08	8.12	2	50
43.	*Acrostichum aureum*	Pteridaceae	Fr	0	0.35	1	25
44.	*Mussaenda polita*	Rubiaceae	Sh	0.20	0.23	1	25
45.	*Spermacoce ruelliae*	Rubiaceae	Fo	3.05	0.12	1	25
46.	*Pentodon pentandrus*	Rubiaceae	Fo	0.41	1.16	2	50
47.	*Zanthoxylum zanthoxyloides*	Rutaceae	Tr	0.20	0.35	1	25
48.	*Scoparia dulcis*	Scrophulariaceae	Fo	0	0.23	1	25
49.	*Waltheria indica*	Sterculiaceae	Fo	1.02	1.51	1	25
50.	*Triuffetta cordifolia*	Tiliaceae	Fo	1.42	0.12	1	25
51.	*Triuffetta pentadra*	Tiliaceae	Fo	0.20	0	1	25
52.	*Typha domingensis*	Typhaceae	Fo	13.41	10.90	2	50
53.	*Starchytarpheta cayenense*	Verbenaceae	Fo	0	0.34	1	25
54.	*Starchytarpheta jamaicensis*	Verbenaceae	Fo	0	0.12	1	25
55.	*Cissus* sp.	Vitaceae	Cl	1.02	0.12	1	25

Appendix 2. Percentage Seasonal Frequency Distribution and Species Occurrences in Epe, Lagos state. Abbreviations are: Keys: FOC, Frequency of Occurrence; RFOC, Relative Frequency of Occurrence; Cl, Climber; Gr, Grass; Tr, Tree; Fo, Forb; Fr, Fern; Se, Sedge; Sh, Shrub.

S/N	Species	Family	Habit	Wet	Dry	FOC	RFOC%
1.	*Asystasia gangetica*	Acanthaceae	Fo	0	4.28	1	33.33
2.	*Cyathula prostrata*	Amaranthaceae	Fo	0	0.53	1	33 33
3.	*Alstonia boonei*	Apocynaceae	Tr	0.28	0.53	1	33.33
4.	*Cyrtosperma senegalense*	Araceae	Fo	8.87	0.53	2	66.67
5.	*Elaeis guineensis*	Araceae	Tr	1.69	2.14	1	33.33
6.	*Raphia hookeri*	Arecaceae	Tr	0.42	0.14	2	66.67
7.	*Raphia vinifera*	Arecaceae	Tr	11.27	0	2	66.67
8.	*Ageratum conyzoides*	Asteraceae	Fo	0	2.14	1	33.33
9.	*Aspilia africana*	Asteraceae	Fo	8.45	2.14	2	66.67
10.	*Chromolaena odorata*	Asteraceae	Fo	9.15	2.67	2	66.67
11.	*Emilia coccinea*	Asteraceae	Fo	0	1.07	1	33.33
12.	*Erigeron floribundus*	Asteraceae	Fo	0	1.07	1	33.33
13.	*Senna rotundifolia*	Caesalpinioideae	Fo	1.41	0	1	33.33
14.	*Ipomoea involucrata*	Convolvulaceae	Cl	0.28	4.81	2	66.67
15.	*Costus afer*	Costaceae	Sh	0	0.53	1	33.33
16.	*Lagenaria breviflora*	Cucurbitaceae	Cl	0	0.53	1	33.33
17.	*Mariscus alternifolius*	Cyperaceae	Se	0	1.07	1	33.33
18.	*Mariscus flabelliformis*	Cyperaceae	Se	1.69	0.53	1	33.33
19.	*Scleria depressa*	Cyperaceae	Se	2.82	1.07	2	66.67
20.	*Dryopteris marginalis*	Dryopteridaceae	Fr	5.63	1.07	2	66.67
21.	*Alchornea cordifolia*	Euphorbiaceae	Sh	9.86	17.11	3	100.00
22.	*Maesobotrya barteri*	Euphorbiaceae	Tr	0.99	0	1	33.33
23.	*Spondianthus preussii*	Euphorbiaceae	Sh	5.63	0	1	33.33
24.	*Anthocleista djalonensis*	Gentianaceae	Tr	0.14	0	1	33.33
25.	*Anthocleista vogelii*	Gentianaceae	Tr	1.41	0	1	33.33
26.	*Solenostemon monostachyus*	Lamiaceae	Fo	0	1.07	1	33.33
27.	*Heteropterys leona*	Malphigiaceae	Sh	0	2.67	1	33.33
28.	*Sida acuta*	Malvaceae	Fo	0.42	0	1	33.33
29.	*Urena lobata*	Malvaceae	Fo	1.27	0	1	33.33
30.	*Dissotis rotundifolia*	Melastomataceae	Fo	3.38	1.60	2	66.67
31.	*Ficus sur*	Moraceae	Tr	0	2.67	1	33.33
32.	*Ficus trichopoda*	Moraceae	Tr	1.41	0	1	33.33
33.	*Ludwigia abyssinica*	Onagraceae	Fo	0	0.53	1	33.33
34.	*Calopogonum mucunoides*	Papilionoideae	Cl	0	1.07	1	33.33
35.	*Desmodium ramossisimum*	Papilionoideae	Fo	1.69	0.53	2	66.67
36.	*Desmodium tortuosum*	Papilionoideae	Fo	0.7	0	1	33.33
37.	*Desmodium triflorum*	Papilionoideae	Fo	0.28	1.07	2	66.67
38.	*Passiflora foetida*	Passifloraceae	Cl	0.42	5.35	1	33.33
39.	*Axonopus compressus*	Poaceae	Gr	0.28	0	1	33.33

S/N	Species	Family	Habit	Wet	Dry	FOC	RFOC%
40.	*Brachiaria deflexa*	Poaceae	Gr	0	5.35	1	33.33
41.	*Digitaria horizontalis*	Poaceae	Gr	3.38	2.14	2	66.67
42.	*Panicum maximum*	Poaceae	Gr	1.41	0	1	33.33
43.	*Sacciolepis africana*	Poaceae	Gr	11.71	12.22	2	66.67
44.	*Sporobolus pyramidalis*	Poaceae	Gr	1.41	0	1	33.33
45.	*Hallea stipulosa*	Rubiaceae	Tr	1.27	0.53	1	33.33
46.	*Pentodon pentandrus*	Rubiaceae	Fo	0.28	14.44	2	66.67
47.	*Psychotria* sp.	Rubiaceae	Sh	0.28	0	1	33.33
48.	*Scoparia dulcis*	Scrophulariaceae	Fo	0	3.74	2	66.67
49.	*Smilax anceps*	Smilacaceae	Cl	0.28	0	1	33.33
50.	*Triumfetta cordifolia*	Tiliaceae	Fo	1.41	0	1	33.33
51.	*Stachytarpheta cayennense*	Verbenaceae	Fo	0.28	2.67	1	33.33
52.	*Cissus* sp.	Vitaceae	Cl	0.14	0.53	1	33.33

Appendix 3. Percentage Seasonal Frequency Distribution and Species Occurrences in Ikorodu, Lagos state. Keys: Abbreviations are: FOC, Frequency of Occurrence; RFOC, Relative Frequency of Occurrence; Cl, Climber; Gr, Grass; Tr, Tree; Fo, Forb; Fr, Fern; Se, Sedge; Sh, Shrub.

S/N	Species	Family	Habit	Wet	Dry	FOC	RFOC
1.	*Asystasia gangetica*	Acanthaceae	Fo	0.52	1.92	2	50
2.	*Commelina diffusa*	Acanthaceae	Fo	1.03	0	1	25
3.	*Gomphrena celosioides*	Amaranthaceae	Fo	0.21	0	1	25
4.	*Alstonia boonei*	Apocynaceae	Tr	0.52	0.27	1	25
5.	*Holarrhena floribunda*	Apocynaceae	Tr	0.21	0	1	25
6.	*Landolphia dulcis*	Apocynaceae	Cl	0.41	0	1	25
7.	*Rauvolfia vomitoria*	Apocynaceae	Tr	1.24	0.27	2	50
8.	*Cyrtosperma senegalense*	Araceae	Fo	4.13	1.37	1	25
9.	*Phoenix reclinata*	Arecaceae	Tr	1.44	2.74	1	25
10.	*Raphia hookeri*	Arecaceae	Tr	0.52	1.37	1	25
11.	*Aspilia africana*	Asteraceae	Fo	2.58	0.82	2	50
12.	*Chromolaena odorata*	Asteraceae	Fo	9	15	2	50
13.	*Emilia coccinea*	Asteraceae	Fo	2.17	2.74	2	50
14.	*Vernonia cinerea*	Asteraceae	Fo	0	0.55	1	25
15.	*Byrsocarpus coccineus*	Connaraceae	Sh	0.52	3.84	1	25
16.	*Ipomoea involucrata*	Convolvulaceae	Cl	2.79	1.37	2	50
17.	*Cyperus articulatus*	Cyperaceae	Se	7.22	5.48	1	25
18.	*Cyperus difformis*	Cyperaceae	Se	0	1.37	1	25
19.	*Cyperus distans*	Cyperaceae	Se	0.31	0	1	25
20.	*Cyperus iria*	Cyperaceae	Se	1.24	1.37	1	25
21.	*Nephrolepis biserrata*	Davalliaceae	Fr	0.21	0	1	25
22.	*Dioscorea alata*	Dioscoreaceae	Cl	0.1	0	1	25
23.	*Dryopteris marginalis*	Dryopteridaceae	Fr	2.06	1.37	1	25
24.	*Alchornea cordifolia*	Euphorbiaceae	Sh	9	4.11	3	75
25.	*Microdesmis puberula*	Euphorbiaceae	Sh	0.21	0	1	25
26.	*Securinega virosa*	Euphorbiaceae	Sh	0.21	0	1	25
27.	*Anthocleista vogelii*	Gentianaceae	Tr	0.83	0.55	2	50
28.	*Harungana madagascariense*	Guttiferae	Tr	3.2	0.27	1	25
29.	*Sida acuta*	Malvaceae	Fo	0.52	4.66	2	50
30.	*Dissotis rotundifolia*	Melastomataceae	Fo	2.27	1.92	1	25
31.	*Mimosa pundica*	Mimosoideae	Fo	0.21	0	1	25
32.	*Ficus eriobotryoides*	Moraceae	Tr	0.21	0	1	25
33.	*Ficus* sp.	Moraceae	Tr	0.1	0	1	25
34.	*Ficus sur*	Moraceae	Tr	0	0.55	1	25
35.	*Musanga cecropidioides*	Moraceae	Tr	0.1	0	1	25
36.	*Ludwigia abyssinica*	Onagraceae	Fo	2.58	2.74	1	25
37.	*Calopogonium mucunoides*	Papilionoideae	Cl	1.03	0	1	25
38.	*Centrosema pubescens*	Papilionoideae	Cl	1.96	1.37	1	25
39.	*Desmodium ramossisimum*	Papilionoideae	Fo	1.55	0	1	25
40.	*Drepanocarpus lanatus*	Papilionoideae	Sh	1.24	3.29	1	25
41.	*Indigofera arrecta*	Papilionoideae	Fo	0.41	0	1	25
42.	*Passiflora foetida*	Passifloraceae	Cl	0.4	0	1	25

S/N	Species	Family	Habit	Wet	Dry	FOC	RFOC
43.	*Phyllanthus muellerianus*	Phyllanthaceae	Sh	0.52	1.37	1	25
44.	*Brachiaria deflexa*	Poaceae	Gr	1.55	0	1	25
45.	*Digitaria horizontalis*	Poaceae	Gr	0	8.22	1	25
46.	*Oplismenus burmannii*	Poaceae	Gr	2.06	0	1	25
47.	*Panicum maximum*	Poaceae	Gr	5.16	6.03	4	100
48.	*Paspalum vaginatum*	Poaceae	Gr	4.13	2.19	2	50
49.	*Pennisetum* sp.	Poaceae	Gr	0.52	0	1	25
50.	*Sporobolus pyramidalis*	Poaceae	Gr	1.65	1.37	2	50
51.	*Acrostichum aureum*	Pteridaceae	Fr	2.58	2.74	1	25
52.	*Rhizophora racemosa*	Rhizophoraceae	Tr	3.41	6.85	1	25
53.	*Morinda morindoides*	Rubiaceae	Sh	5.68	5.48	1	25
54.	*Mussaenda polita*	Rubiaceae	Sh	2.06	0	1	25
55.	*Spermacoce ocymoides*	Rubiaceae	Fo	1.03	0	1	25
56.	*Spermacoce ruelliae*	Rubiaceae	Fo	1.03	0	1	25
57.	*Allophylus africanus*	Sapindaceae	Sh	0.21	0	1	25
58.	*Smilax anceps*	Smilacaceae	Cl	1.03	0	2	50
59.	*Sterculia tragacantha*	Sterculiaceae	Tr	0	0.55	1	25
60.	*Triumffeta petandra*	Tiliaceae	Fo	0.62	0	1	25
61.	*Typha domingensis*	Typhaceae	Fo	0.21	0	1	25
62.	*Clerodendrum polycephalum*	Verbenaceae	Sh	1.03	0	1	25
63.	*Stachytarpheta jamaicensis*	Verbenaceae	Fo	0.72	0.55	1	25
64.	*Stachytarpheta cayennense*	Verbenaceae	Fo	0.8	0.62	1	25
65.	*Vitex grandifolia*	Verbenaceae	Tr	0.21	0	1	25
66.	*Cissus aralioides*	Vitaceae	Cl	0.21	0	1	25