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Plant species composition, distribution and diversity in freshwater wetlands in Rivers State, Nigeria

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ABSTRACT

An assessment of plant species composition, distributions and diversity of Eliozu and Kpite freshwater wetlands to determine the impact of social settings (rural and urban) on plant community was carried out. The study was carried out during the wet and dry seasons of 2020 and 2021 respectively. Systematic sampling technique was used to locate 5 sample plots of 10 × 20 m sizes along a 20 × 20 m belt transect. Within the plots, plant species were identified to species level, enumerated and analysis based on phytosociological indices was carried out. Results revealed that at wet season, Kpite had 45 species which belong to 25 families, Eliozu had 26 species which are distributed under 17 families. Eighteen (18) and 15 species in Kpite and Eliozu sites respectively had 100% frequency of occurrence, 14 and 13 species had high abundance in Kpite and Eliozu respectively while 16 and 14 species had high density at Kpite and Eliozu respectively. Species diversity were 3.5 for Kpite and 2.9 for Eliozu, species richness: 5.3 for Kpite and 3.1 for Eliozu while species evenness was 0.9 for both sites. Based on observed higher species composition, frequency of occurrence, abundance, density, diversity and richness values, the Kpite site is more preserved than Eliozu site. Therefore, it is recommended that active implementation of ecosystem conservation and protection measures are required to sustain the existence of Eliozu freshwater wetland.

Key words: Freshwater wetland, Species composition, Species diversity, Importance value index, Niger Delta Wetland, Species richness

INTRODUCTION

Wetlands play roles in global climate regulation, maintenance of hydrological cycle, biodiversity conservation and human welfare (Hu *et al.,* 2017). They provide direct and indirect services (Xu *et al*., 2019; Asgher *et al*., 2021). Everard *et al*. (2019) listed wetland goods to include food, fibre, ornamental resources, raw materials for cosmetics, emulsifiers, medicinal resources, carbon sequestration etc. They vary greatly due to regional and local differences in hydrology, soil properties, climate, landscape topography and human disturbances (Volik *et al.,* 2020). These points of diversity are considered important environmental variables which determine plant species composition, diversity and distribution in wetlands (Wang *et al*., 2019; Xia *et al*., 2021). Therefore, wetlands support diverse plant species and provide ecosystem services (Gómez-Baggethun *et al*., 2019; Alikhani *et al*., 2021) and store carbon (Shwamyil *et al*., 2020). They serve as natural structures for flood control as dykes, dams and embankments (Kumar *et al*., 2021).

Naturally, plants occur in communities in the environment. Each community possesses diverse species, growth forms, structures, dominance and successional trends.

Numerical data on plant community characteristics enable determination of dominant species and other vegetation characteristics of plant community. To know their dominance, some analytical characters such as frequency, densities, abundance of species in a community must be assessed and determined.

Nigeria has a large expanse of wetland area called the Niger Delta. This wetland is located at the southern part of the country. Not much is known on the floral composition of this important ecosystem. Hence, two specific sites – Kpite and Eliozu freshwater wetlands were selected for assessment to determine their plant species composition and other species characteristics with the view to determine any impact of social setting on the vegetation of the areas. This was considered important because, identification of the local flora will expand knowledge of indigenous wetland plants of the area (Lakshmanan & Ganthi, 2018). The information generated will be of immense value to ecologists, environmentalist and ethnobotanists who study the use of plants by man.

MATERIALS AND METHODS

Study Sites

This study was carried out at two wetland sites. These sites were:

Kpite Freshwater Wetland

Kpite Freshwater Wetland is at Kpite, a rural suburb in Tai Local Government Area (LGA) of Rivers State. It is located at latitudes 4˚43'52.698"N and longitude 7˚ 18' 9.234"E (Fig. 1). Tai LGA is one of the LGAs that makeup the Ogonis in Rivers State. The wetland has several channels but Or-Gbor, located at the boundary between Kpite and Korokoro-Tai was chosen for the study. As a rural setting, the main activities of its people include farming, fishing and hunting. Due to these activities, the vegetation has experienced perturbation from these activities, especially clearance for farming and felling of trees for timber and fuel wood etc. These activities have led to the conversion of some expanse of this swamp-land to farmland.

Eliozu Freshwater Wetland

Eliozu Freshwater Swamp is in the geopolitical area called Obio/Akpor LGA which together with Port Harcourt LGA makeup Port Harcourt metropolis and the state headquarter of Rivers State (Fig. 2). This site is positioned at latitude 4˚ 51' 42.186" N and longitude 7˚ 1' 29.058"E. Eliozu town is large with a high density of human population. Within the area, there are residential accommodations, shops, motor parks, market, abattoir, motor highways, mechanic workshops and waste dumps. This area experiences high anthropogenic interferences from human activities.

Figure 1: Raster map of Tai L.G.A., Rivers State showing Kpite town

Figure 2: Raster map of Obio/Akpor L.G.A., Rivers State showing Eliozu town

Phytodiversity Studies

Phytodiversity study was carried out during the dry and wet seasons of 2020 and 2021 respectively. Belt transect of 100 x 20 m containing five 10 x 20 m quadrats systematically located along the transect was sampled for data collection (Elzinga *et al*., 2001; Phillips et al., 2003). At each quadrat, plant species found growing within it were identified to species level with the aid of appropriate literatures, manual checklist and Akobundu and Agyakwa (1998); Etukudo (2003); Aigbokhan (2014) as reference books. Species populations were enumerated by direct count; plant growth habits and their conservation status according to International Union for Conservation of Nature (IUCN) standard were noted and checked respectively recorded.

From the data gathered, species frequency of occurrence, relative frequency, species abundance, relative abundance, species density, relative density, Importance Value Index (IVI) and species diversity indices were calculated mathematically using appropriate formulae as contained in Cottam and Curtis (1956), Husch *et al*. (2003) and Mori *et al*. (1983) as follows:

Frequency

$$= \frac{\text{Total No. of sampling units in which the specie exists}}{\text{Total number of sampling units studied}} X\ 100$$

Relative Frequency (RF)

$$= \frac{\text{Frequency of individual species}}{\text{Total frequency of all species}} X\ 100$$

Abundance

$$= \frac{\text{Total Number of individual species in all sampling units}}{\text{Total number of sampling units in which the species occurred}}$$

Relative Abundance (RA)

$$= \frac{\text{Abundance of individual species}}{\text{Total Abundance of all species}} \text{ X } 100$$

Density

$$= \frac{\text{Total Number of individual species in all the sampling plots}}{\text{Total number of sampling plots used}}$$

Relative Density (RD)

$$= \frac{\text{Density of individual species}}{\text{Total Density of all species}} \text{ X } 100$$

Species Important Value Index (IVI) = Relative Frequency + Relative Abundance + Relative Density

Species diversity was calculated using Shannon – Wiener diversity index

Shannon – Wiener diversity index, $H` = -\sum_{i=1}^{s}(\text{P}i)[\log(\text{P}i)]$

Where:

H`= Shannon's index of diversity

Σ = is the symbol for sum

Pi = proportion (n/N) of total abundance represented by ith species

log = logarithm

S = the number of species

Species Richness was calculated with Margalef Species Richness Index using the formula:

Margalef Species Richness Index**, M** = $\frac{(\boldsymbol{S-1})}{\boldsymbol{ln\ N}}$

Where:

S = Total number of species in a community,

N = Number of individuals and

ln = Natural logarithm.

Species Evenness Index, E: this was calculated using Pilou's Index.

Pilou's Species Evenness index, E = $\frac{\mathbf{H}}{\log S}$

Where:

E = Pilou Evenness Index

H = Shannon – Wiener's Index and;

S = Number of species.

Statistical Analyses and Data Presentation

Data obtained on the variables of the study were analysed using Microsoft Excel Spreadsheet, 2016 version to calculate arithmetic means, frequency, abundance, density, RF, RA, RD and species IVI. Results obtained of the study are presented in tables.

RESULTS

Results of plant species composition, abundance and diversity of the study areas are presented as follows.

Result of species composition assessment of Kpite and Eliozu freshwater wetland sites are displayed in Table 1. At Kpite, 45 plant species which belong to 25 families were observed in the wet season whereas 41 plant species which belong to 23 families were recorded in the dry season. The dominant plant families observed were the Asteraceae (5); Euphorbiaceae (4); Poaceae, Fabaceae, Gentianaceae and Araceae (3). At Eliozu, 26 species of 17 families were observed during

the wet season assessment while 25 species of 16 families were recorded in dry season. The dominant plant families recorded are: Poaceae (4), Aracaceae (3) and Cyperaceae (3). Plant growth habits analysis showed vegetation was composed of 25 herbs, 14 trees and 5 shrubs at Kpite site while Eliozu has 16 herbs, 7 trees and 2 shrubs. This reveals that herbaceous forms were the dominant vegetation at both sites. Results also show that all species encountered were of least concern in conservation status. Species found include conspicuous plants such as *Alchornia.* spp., *Alstonia boonei. Anthocleista* spp., *bambusa vulgaris, Raphia* spp. *Chromolaena ordorata* and so forth. Herbaceous plants such as *Cyperus rotundus, Commelina* spp., *Emilia* spp., *Kyllinga brevifolia* etc. and some plants economic importance such as *Manihot esculentum, Musa paradisiaca* and so forth.
Species frequency and relative frequency of occurrence result is in Table 2. The result elucidated that 18 species were observed in all quadrats i.e. 100% occurrence; 4 species had 80% occurrence; 12 species had 60% and 10 species had 40% occurrence in the sampled quadrats (Table 2) during the wet season sampling at Kpite site.

Eliozu site recorded 15 species in all quadrats (i.e. 100%); 1 species had 80% occurrence; four species had 60% occurrence and six species had 40% occurrence in the wet season sampling. The species with high frequencies of occurrence had corresponding high relative frequencies of occurrence of 2.99 and 4.90 for Kpite and Eliozu respectively (Table 2). Between seasons, there were decrease in frequency of occurrence from wet to dry season in 9 species at Kpite site and 1 species at Eliozu site.

Table 1: Species Composition of the Studied Sites

S/N	Species	Family	Habit	Conservation Status	Kpite		Eliozu	
					Wet	Dry	Wet	Dry
1	*Ageratum conyzoides* L.	Asteraceae	Herb	LC	82	69	0	0
2	*Alchornea cordifolia* Müll.Arg.	Euphorbiaceae	Shrub	LC	67	51	109	109
3	*Alchornea laxifolia* (Benth.) Pax & K Hoffm.	Euphorbiaceae	Tree	LC	29	25	0	0
4	*Alstonia boonei* De Wild	Apocynaceae	Tree	LC	12	12	5	5
5	*Alternanthera philoxeroides* (Mart.) Griseb.	Amaranthaceae	Herb	LC	156	130	156	133
6	*Ambrosia artemisiifolia* L.	Gentiaceae	Herb	LC	91	80	0	0
7	*Anthocleista djalonensis* A Chev.	Gentianaceae	Tree	LC	16	16	0	0
8	*Anthocleista grandiflora* L.	Gentianaceae	Tree	LC	27	27	9	9
9	*Anthocleista vogelii* Planch.	Gentianaceae	Tree	LC	31	31	10	10
10	*Axonopus compressus* (Sw.) P.Beauv.	Poaceae	Herb	LC	0	0	138	117
11	*Bambusa vulgaris* Schrad. ex J.C.Wendl.	Poaceae	Tree	LC	16	29	15	24
12	*Chromolaena odorrata* (L.) R. King & H. Robinson).	Asteraceae	Shrub	LC	137	117	0	0
13	*Cleistopholis patens* (Benth.) Engl. & Diels	Annonaceae	Tree	LC	14	14	0	0
14	*Commelina communis* L.	Commelinaceae	Herb	LC	91	79	0	0
15	*Commelina latifolia* Hochst. ex A. Rich.	Commelinaceae	Herb	LC	85	65	149	137
16	*Cordyline fruticosa* (L.) A.Chev.	Asparagaceae	Shrub	LC	91	0	0	0
17	*Costus afer* Ker-Gawl	Costuceae	Herb	LC	51	60	0	0
18	*Cyperus rotundus* L.	Cyperaceae	Herb	LC	168	121	168	128
19	*Cyperus Strigosus* L.	Cyperaceae	Herb	LC	225	182	225	169
20	*Dieffenbachia seguine* (Jacq.) Schott	Araceae	Herb	LC	14	0	0	0
21	*Elaeis guineensis* Jacq.	Arecaceae	Tree	LC	25	19	0	0
22	*Emilia sonchifolia* (L.) DC. ex Wight.	Asteraceae	Herb	LC	175	148	168	138
23	*Euphorbia hirta* L.	Euphorbiaceae	Herb	LC	38	25	143	117
24	*Ipomea involucrata* P.Beauv.	Convolvulaceae	Herb	LC	0	0	143	117
25	*Kyllinga brevifolia* Rottb.	Cyperaceae	Herb	LC	161	129	203	149
26	*Manihot esculentum* Crantz.	Euphorbiaceae	Shrub	LC	230	313	0	0
27	*Mikania scandens* B.L.Rob.	Asteraceae	Herb	LC	68	0	0	0
28	*Musa paradisiaca* L.	Musaceae	Shrub	LC	42	54	0	0
29	*Musanga cecropioides* R.Br. & Tedlie	Urticaceae	Tree	LC	11	11	5	5
30	*Nephrolepis biserrata* (Sw.) Schott.	Oleandraceae	Herb	LC	180	38	322	0
31	*Nymphaea lotus* L.	Nymphaeaceae	Herb	LC	50	50	0	0
32	*Panicum maximum* Jacq.	Poaceae	Herb	LC	72	67	110	93
33	*Peltandra virginica* (L.) Schott.	Araceae	Tree	LC	108	91	160	147
34	*Pentaclethra macrophylla* Benth.	Fabaceae	Tree	LC	8	8	0	0
35	*Phyllanthus amarus* Schumach. & Thonn.	Phyllanthaceae	Herb	LC	125	62	82	53
36	*Phyllanthus urinaria* L.	Phyllanthaceae	Herb	LC	155	133	83	72
37	*Phytolacca americana* L.	Phytolaccaceae	Herb	LC	34	49	0	0

38	*Pteridium aquilinum*(L.) Kuhn	Dennstaedtiaceae	Herb	LC	134	94	347	259
39	*Pueraria phaseoloides* (Roxb.) Benth.	Fabaceae	Herb	LC	174	157	254	232
40	*Raphia hookeri* G.Mann & H.Wendl.	Arecaceae	Tree	LC	63	54	77	77
41	*Raphia vinifera* P.Beauv.	Arecaceae	Tree	LC	30	30	72	72
42	*Senna siamea* (Lam.) Irwin et Barneby	Fabaceae	Herb	LC	14	14	0	0
43	*Setaria pumila* (Poir.) Roem. & Schult.	Poaceae	Tree	LC	252	143	474	415
44	*Sida acuta* Burm.f.	Malvaceae	Herb	LC	153	134	0	0
45	*Smilax aspera* L.	Smilacaceae	Herb	LC	70	56	0	0
46	*Syngonium podophyllum* Schott	Araceae	Tree	LC	50	0	0	0
47	*Tectona grandis* L.f.	Lamiaceae	Tree	LC	0	0	5	5
48	*Thalia geniculata* L.	Marantaceae	Herb	LC	130	121	0	0
	Total				**45**	**41**	**26**	**24**

LC = least concern in conservation status

Table 2: Species Frequency and Relative Frequency of occurrence

S/N	Species	Kpite				Eliozu			
		Wet		Dry		Wet		Dry	
		%F	RF(%)	%F	RF(%)	%F	RF(%)	%F	RF(%)
1	*Ageratum conyzoides* L.	60	1.80	60	1.95	0	0.00	0	0.00
2	*Alchornea cordifolia* Müll.Arg.	100	2.99	100	3.25	100	4.90	100	4.95
3	*Alchornea laxifolia* (Benth.) Pax & K Hoffm.	60	1.80	60	1.95	0	0.00	0	0.00
4	*Alstonia boonei* De Wild	60	1.80	60	1.95	40	1.96	40	1.98
5	*Alternanthera philoxeroides* (Mart.) Griseb.	100	2.99	100	3.25	100	4.90	100	4.95
6	*Ambrosia artemisiifolia* L.	60	1.80	60	1.95	0	0.00	0	0.00
7	*Anthocleista djalonensis* A Chev.	60	1.80	60	1.95	0	0.00	0	0.00
8	*Anthocleista grandiflora* L.	80	2.40	80	2.60	60	2.94	60	2.97
9	*Anthocleista vogelii* Planch.	60	1.80	60	1.95	60	2.94	60	2.97
10	*Axonopus compressus* (Sw.) P. Beauv.	0	0.00	0	0.00	60	2.94	60	2.97
11	*Bambusa vulgaris* Schrad. ex J.C. Wendl.	40	1.20	60	1.95	40	1.96	40	1.98
12	*Chromolaena odorata* (L.) R. King & H. Robinson).	60	1.80	60	1.95	0	0.00	0	0.00
13	*Cleistopholis patens* (Benth.) Engl. & Diels	60	1.80	60	1.95	0	0.00	0	0.00
14	*Commelina communis* L.	100	2.99	100	3.25	0	0.00	0	0.00
15	*Commelina latifolia* Hochst. ex A. Rich.	60	1.80	60	1.95	100	4.90	100	4.95
16	*Cordyline fruticosa* (L.) A.Chev.	80	2.40	0	0.00	0	0.00	0	0.00
17	*Costus afer* Ker-Gawl	40	1.20	40	1.30	0	0.00	0	0.00
18	*Cyperus rotundus* L.	100	2.99	100	3.25	100	4.90	100	4.95

19	*Cyperus Strigosus* L.	100	2.99	100	3.25	100	4.90	100	4.95
20	*Dieffenbachia seguine* (Jacq.) Schott	40	1.20	0	0.00	0	0.00	0	0.00
21	*Elaeis guineensis* Jacq.	100	2.99	80	2.60	0	0.00	0	0.00
22	*Emilia sonchifolia* (L.) DC. ex Wight.	100	2.99	100	3.25	60	2.94	60	2.97
23	*Euphorbia hirta* L.	40	1.20	40	1.30	100	4.90	100	4.95
24	*Ipomea involucrata* P. Beauv.	0	0.00	0	0.00	100	4.90	100	4.95
25	*Kyllinga brevifolia* Rottb.	100	2.99	100	3.25	100	4.90	100	4.95
26	*Manihot esculentum* Crantz.	100	2.99	100	3.25	0	0.00	0	0.00
27	*Mikania scandens* B. L. Rob.	60	1.80	0	0.00	0	0.00	0	0.00
28	*Musa paradisiaca* L.	100	2.99	100	3.25	0	0.00	0	0.00
29	*Musanga cecropioides* R.Br. & Tedlie	80	2.40	60	1.95	40	1.96	40	1.98
30	*Nephrolepis biserrata* (Sw.) Schott.	100	2.99	60	1.95	100	4.90	0	0.00
31	*Nymphaea lotus* L.	60	1.80	60	1.95	0	0.00	0	0.00
32	*Panicum maximum* Jacq.	40	1.20	40	1.30	40	1.96	40	1.98
33	*Peltandra virginica* (L.) Schott.	100	2.99	100	3.25	100	4.90	100	4.95
34	*Pentaclethra macrophylla* Benth.	40	1.20	40	1.30	0	0.00	0	0.00
35	*Phyllanthus amarus* Schumach. & Thonn.	60	1.80	60	1.95	40	1.96	40	1.98
36	*Phyllanthus urinaria* L.	80	2.40	80	2.60	80	3.92	80	3.96
37	*Phytolacca americana* L.	40	1.20	60	1.95	0	0.00	0	0.00
38	*Pteridium aquilinum* (L.) Kuhn	100	2.99	80	2.60	100	4.90	100	4.95
39	*Pueraria phaseoloides* (Roxb.) Benth.	100	2.99	100	3.25	100	4.90	80	3.96
40	*Raphia hookeri* G.Mann & H.Wendl.	100	2.99	80	2.60	100	4.90	100	4.95
41	*Raphia vinifera* P.Beauv.	100	2.99	100	3.25	100	4.90	100	4.95
42	*Senna siamea* (Lam.) Irwin et Barneby	40	1.20	40	1.30	0	0.00	0	0.00
43	*Setaria pumila* (Poir.) Roem. & Schult.	100	2.99	100	3.25	100	4.90	100	4.95
44	*Sida acuta* Burm.f.	100	2.99	100	3.25	0	0.00	0	0.00
45	*Smilax aspera* L.	40	1.20	40	1.30	0	0.00	0	0.00
46	*Syngonium podophyllum* Schott	40	1.20	0	0.00	0	0.00	0	0.00
47	*Tectona grandis* L.f.	0	0.00	0	0.00	40	1.96	40	1.98
48	*Thalia geniculata* L.	100	2.99	100	3.25	0	0.00	0	0.00

Species abundance and relative abundance recorded at Kpite and Eliozu are in Table 3. Fourteen (14) species had high abundance value of over 25 at Kpite while Eliozu had 13 species. Of the species with high abundance in the sampled wetland were *Alternanthera* sp., *Commelina latifolia, Cyperus* spp., *Emilia sonchifolia, Panicum*

maximum, Nephrolepis biserata and *Phyllanthus* sp. had high abundance in both Kpite and Eliozu freshwater wetland sites.

Conversely, 11 species, which include *Alstonia boonei, Anthocliesta* sp., *Bambusa vulgaris, Elaeis guineensis, Musa* sp., *Musanga cecropoides* etc. recorded low abundance at Kpite while five species (*Alstonia boonei, Anthocliesta sp., Bambusa vulgaris, Musanga cecropoides, Tectona grandis*) had low species abundance at Eliozu. Furthermore, *Alstonia boonei, Anthocliesta* sp., *Bambusa vulgaris, Musanga cecropoides* were abundant at both sites.

In Table 4, species density and relative density of Kpite and Eliozu freshwater wetlands showed that 16 species of Kpite site had high densities with *Setaria pumila* having the highest (50%). This was followed by those of *Manihot esculentum* (46%) and *Cyperus Strigosus* (45%). However, low species density results were recorded for 13 species, with the least value of 1.6% recorded for *Pentaclethra macrophylla* followed by 2.2% for *Musa paradisiaca*, 2.4 % for *Alstonia boonei* during the dry season.

Eliozu wetland had 14 species with species density of *S. pumila* (94%), *Pteridium aquilinum* (69%), *N. biserrata* (64%) while *C. strigosus* and *Kyllinga brevifolia* had 45% and 40% respectively in the dry season. Four (species recorded low density with *Alstonia boonei* having the least density (1.0%). Nine species (*A. philoxeroides, Cyperus* spp., *E. sonchifolia, K. brevifolia, N. biserrata, P. virginica, P. aquilinum, P. phaseoloides* and *S. pumila*) were common and had high density in both sites while five species (*A. boonei, Anthocleista* spp., *B. vulgaris* and *M. cecropioides*) had low density in both sites.

Between Kpite and Eliozu, species with high relative density include *S. pumila, M. esculentum, E. sonchifolia, C. strigosus, K. brevifolia, N. biserrata, C. rotundus, P. phaseoloides, A. philoxeroides* and *S. acuta.* Species with least density relative density were *P. macrophylla B. vulgaris, M. cecropioides, A. boonei, C. patens, S. siamea* and *D. seguine*.

Species importance value index, IVI results are in Table 5. Species of high IVI in Kpite swamp site include *S. pumila*: 14.3, *M. esculenta*: 13.2, *N. biserrata*: 11.1, *P. phaseoloides*: 10.8, *K. brevifolia*: 10.2, *P. urinaria*: 10.1, *A. philoxeroides*: 10.0 (Table 5). Conversely, the following species: *D. seguine:* 2.2, *B. vulgaris*: 2.4, A. *boonei*: 2.5, *C. patens*: 2.6, *A. djalonensis*: 2.7 and M. *cecropioides*: 2.9 with *P. macrophylla*, recorded the least IVI of 1.8 from the Kpite site.

Similarly, *A. cordifolia, A. philoxeroides, S. pumila, N. biserrata* and so forth recorded high IVI of 10.4, 10.0, 14.3 and 11.1 respectively (Table 5) while *A. boonei, Anthocleista* spp., *B. vulgaris, M.* cecropoides and *T. grandis* recorded low IVI results.

Species diversity, species richness and species evenness assessment results are presented in Table 6. Species diversity was higher in Kpite site compared to Eliozu site. Species diversity was the same between the seasons in both sites. Kpite site was richer in species variety than Eliozu. With values of 5.3 and 4.9 for the wet and dry seasons' assessments respectively at Kpite, these implied that slight seasonal variation in species richness. Conversely, at Eliozu, species richness value of 3 was recorded for both seasons and that means no seasonal difference in species richness. Species evenness is the same for both sites and seasons of assessment (Table 6). This signifies ecosystem similarity between the two wetlands.

Table 3: Species Abundance and Relative Abundance of the Study Studied Sites

S/N	Species	Kpite				Eliozu			
		Wet		Dry		Wet		Dry	
		A	RA(%)	A	RA(%)	A	RA(%)	A	RA(%)
1	*Ageratum conyzoides* L.	27.3	2.70	23.0	2.83	0.0	0.00	0.0	0.00
2	*Alchornea cordifolia* Müll.Arg.	13.4	1.32	10.2	1.25	21.8	2.54	21.8	2.93
3	*Alchornea laxifolia* (Benth.) Pax & K Hoffm.	9.7	0.95	8.3	1.03	0.0	0.00	0.0	0.00
4	*Alstonia boonei* De Wild	4.0	0.39	4.0	0.49	2.5	0.29	2.5	0.34
5	*Alternanthera philoxeroides* (Mart.) Griseb.	31.2	3.08	26.0	3.20	31.2	3.64	26.6	3.57
6	*Ambrosia artemisiifolia* L.	30.3	2.99	26.7	3.28	0.0	0.00	0.0	0.00
7	*Anthocleista djalonensis* A Chev.	5.3	0.53	5.3	0.66	0.0	0.00	0.0	0.00
8	*Anthocleista grandiflora* L.	6.8	0.67	6.8	0.83	3.0	0.35	3.0	0.40
9	*Anthocleista vogelii* Planch.	10.3	1.02	10.3	1.27	3.3	0.39	3.3	0.45
10	*Axonopus compressus* (Sw.) P.Beauv.	0.0	0.00	0.0	0.00	46.0	5.37	39.0	5.23
11	*Bambusa vulgaris* Schrad. ex J.C.Wendl.	8.0	0.79	9.7	1.19	7.5	0.88	12.0	1.61
12	*Chromolaena odorrata* (L.) R. King & H. Robinson).	45.7	4.50	39.0	4.80	0.0	0.00	0.0	0.00
13	*Cleistopholis patens* (Benth.) Engl. & Diels	4.7	0.46	4.7	0.57	0.0	0.00	0.0	0.00
14	*Commelina communis* L.	18.2	1.79	15.8	1.94	0.0	0.00	0.0	0.00
15	*Commelina latifolia* Hochst. ex A. Rich.	28.3	2.79	21.7	2.67	29.8	3.48	27.4	3.68
16	*Cordyline fruticosa* (L.) A.Chev.	22.8	2.24	0.0	0.00	0.0	0.00	0.0	0.00
17	*Costus afer* Ker-Gawl	25.5	2.51	30.0	3.69	0.0	0.00	0.0	0.00
18	*Cyperus rotundus* L.	33.6	3.31	24.2	2.98	33.6	3.92	25.6	3.44
19	*Cyperus Strigosus* L.	45.0	4.44	36.4	4.48	45.0	5.25	33.8	4.54
20	*Dieffenbachia seguine* (Jacq.) Schott	7.0	0.69	0.0	0.00	0.0	0.00	0.0	0.00
21	*Elaeis guineensis* Jacq.	5.0	0.49	4.8	0.58	0.0	0.00	0.0	0.00
22	*Emilia sonchifolia* (L.) DC. ex Wight.	35.0	3.45	29.6	3.64	56.0	6.54	46.0	6.17

23	*Euphorbia hirta* L.	19.0	1.87	12.5	1.54	28.6	3.34	23.4	3.14
24	*Ipomea involucrata* P.Beauv.	0.0	0.00	0.0	0.00	28.6	3.34	23.4	3.14
25	*Kyllinga brevifolia* Rottb.	32.2	3.18	25.8	3.17	40.6	4.74	29.8	4.00
26	*Manihot esculentum* Crantz.	46.0	4.54	62.6	7.70	0.0	0.00	0.0	0.00
27	*Mikania scandens* B.L.Rob.	22.7	2.24	0.0	0.00	0.0	0.00	0.0	0.00
28	*Musa paradisiaca* L.	8.4	0.83	10.8	1.33	0.0	0.00	0.0	0.00
29	*Musanga cecropioides* R.Br. & Tedlie	2.8	0.27	3.7	0.45	2.5	0.29	2.5	0.34
30	*Nephrolepis biserrata* (Sw.) Schott.	36.0	3.55	12.7	1.56	64.4	7.52	0.0	0.00
31	*Nymphaea lotus* L.	16.7	1.64	16.7	2.05	0.0	0.00	0.0	0.00
32	*Panicum maximum* Jacq.	36.0	3.55	33.5	4.12	55.0	6.42	46.5	6.24
33	*Peltandra virginica* (L.) Schott.	21.6	2.13	18.2	2.24	32.0	3.73	29.4	3.95
34	*Pentaclethra macrophylla* Benth.	4.0	0.39	4.0	0.49	0.0	0.00	0.0	0.00
35	*Phyllanthus amarus* Schumach. & Thonn.	41.7	4.11	20.7	2.54	41.0	4.78	26.5	3.56
36	*Phyllanthus urinaria* L.	38.8	3.82	33.3	4.09	20.8	2.42	18.0	2.42
37	*Phytolacca americana* L.	17.0	1.68	16.3	2.01	0.0	0.00	0.0	0.00
38	*Pteridium aquilinum* (L.) Kuhn	26.8	2.64	23.5	2.89	69.4	8.10	51.8	6.95
39	*Pueraria phaseoloides* (Roxb.) Benth.	34.8	3.43	31.4	3.86	50.8	5.93	58.0	7.79
40	*Raphia hookeri* G. Mann & H.Wendl.	12.6	1.24	13.5	1.66	15.4	1.80	15.4	2.07
41	*Raphia vinifera* P.Beauv.	6.0	0.59	6.0	0.74	14.4	1.68	14.4	1.93
42	*Senna siamea* (Lam.) Irwin et Barneby	7.0	0.69	7.0	0.86	0.0	0.00	0.0	0.00
43	*Setaria pumila* (Poir.) Roem. & Schult.	50.4	4.97	28.6	3.52	94.8	11.06	83.0	11.14
44	*Sida acuta* Burm.f.	30.6	3.02	26.8	3.30	0.0	0.00	0.0	0.00
45	*Smilax aspera* L.	35.0	3.45	28.0	3.44	0.0	0.00	0.0	0.00
46	*Syngonium podophyllum* Schott	25.0	2.47	0.0	0.00	0.0	0.00	0.0	0.00
47	*Tectona grandis* L.f.	0.0	0.00	0.0	0.00	2.5	0.29	2.5	0.34
48	*Thalia geniculata* L.	26.0	2.56	24.2	2.98	0.0	0.00	0.0	0.00

Table 4: Species Density and Relative Density of the Studied Sites

S/N	Species	Kpite				Eliozu			
		Wet		Dry		Wet		Dry	
		D	RD(%)	D	RD(%)	D	RD(%)	D	RD(%)
1	*Ageratum conyzoides* L.	16.4	2.07	13.8	2.14	0.0	0.00	0.0	0.00
2	*Alchornea cordifolia* Müll. Arg.	13.4	1.69	10.2	1.58	21.8	2.97	21.8	3.46
3	*Alchornea laxifolia* (Benth.) Pax & K Hoffm.	5.8	0.73	5.0	0.78	0.0	0.00	0.0	0.00
4	*Alstonia boonei* De Wild	2.4	0.30	2.4	0.37	1.0	0.14	1.0	0.16
5	*Alternanthera philoxeroides* (Mart.) Griseb.	31.2	3.94	26.0	4.04	31.2	4.25	26.6	4.23
6	*Ambrosia artemisiifolia* L.	18.2	2.30	16.0	2.49	0.0	0.00	0.0	0.00
7	*Anthocleista djalonensis* A Chev.	3.2	0.40	3.2	0.50	0.0	0.00	0.0	0.00
8	*Anthocleista grandiflora* L.	5.4	0.68	5.4	0.84	1.8	0.25	1.8	0.29
9	*Anthocleista vogelii* Planch.	6.2	0.78	6.2	0.96	2.0	0.27	2.0	0.32
10	*Axonopus compressus* (Sw.) P.Beauv.	0.0	0.00	0.0	0.00	27.6	3.76	23.4	3.72
11	*Bambusa vulgaris* Schrad. ex J.C.Wendl.	3.2	0.40	5.8	0.90	3.0	0.41	4.8	0.76
12	*Chromolaena odorrata* (L.) R. King & H. Robinson).	27.4	3.46	23.4	3.64	0.0	0.00	0.0	0.00
13	*Cleistopholis patens* (Benth.) Engl. & Diels	2.8	0.35	2.8	0.44	0.0	0.00	0.0	0.00
14	*Commelina communis* L.	18.2	2.30	15.8	2.45	0.0	0.00	0.0	0.00
15	*Commelina latifolia* Hochst. ex A. Rich.	17.0	2.15	13.0	2.02	29.8	4.06	27.4	4.35
16	*Cordyline fruticosa* (L.) A.Chev.	18.2	2.30	0.0	0.00	0.0	0.00	0.0	0.00
17	*Costus afer* Ker-Gawl	10.2	1.29	12.0	1.86	0.0	0.00	0.0	0.00
18	*Cyperus rotundus* L.	33.6	4.25	24.2	3.76	33.6	4.58	25.6	4.07
19	*Cyperus Strigosus* L.	45.0	5.69	36.4	5.66	45.0	6.13	33.8	5.37
20	*Dieffenbachia seguine* (Jacq.) Schott	2.8	0.35	0.0	0.00	0.0	0.00	0.0	0.00
21	*Elaeis guineensis* Jacq.	5.0	0.63	3.8	0.59	0.0	0.00	0.0	0.00
22	*Emilia sonchifolia* (L.) DC. ex Wight.	35.0	4.42	29.6	4.60	33.6	4.58	27.6	4.39
23	*Euphorbia hirta* L.	7.6	0.96	5.0	0.78	28.6	3.90	23.4	3.72
24	*Ipomea involucrata* P.Beauv.	0.0	0.00	0.0	0.00	28.6	3.90	23.4	3.72
25	*Kyllinga brevifolia* Rottb.	32.2	4.07	25.8	4.01	40.6	5.53	29.8	4.74
26	*Manihot esculentum* Crantz.	46.0	5.82	62.6	9.73	0.0	0.00	0.0	0.00
27	*Mikania scandens* B.L.Rob.	13.6	1.72	0.0	0.00	0.0	0.00	0.0	0.00
28	*Musa paradisiaca* L.	8.4	1.06	10.8	1.68	0.0	0.00	0.0	0.00
29	*Musanga cecropioides* R.Br. & Tedlie	2.2	0.28	2.2	0.34	1.0	0.14	1.0	0.16
30	*Nephrolepis biserrata* (Sw.) Schott.	36.0	4.55	7.6	1.18	64.4	8.77	0.0	0.00

S/N		Kpite				Eliozu			
		Wet		Dry		Wet		Dry	
		D	RD(%)	D	RD(%)	D	RD(%)	D	RD(%)
32	*Panicum maximum* Jacq.	14.4	1.82	13.4	2.08	22.0	3.00	18.6	2.96
33	*Peltandra virginica* (L.) Schott.	21.6	2.73	18.2	2.83	32.0	4.36	29.4	4.67
34	*Pentaclethra macrophylla* Benth.	1.6	0.20	1.6	0.25	0.0	0.00	0.0	0.00
35	*Phyllanthus amarus* Schumach. & Thonn.	25.0	3.16	12.4	1.93	16.4	2.23	10.6	1.68
36	*Phyllanthus urinaria* L.	31.0	3.92	26.6	4.13	16.6	2.26	14.4	2.29
37	*Phytolacca americana* L.	6.8	0.86	9.8	1.52	0.0	0.00	0.0	0.00
38	*Pteridium aquilinum* (L.) Kuhn	26.8	3.39	18.8	2.92	69.4	9.46	51.8	8.23
39	*Pueraria phaseoloides* (Roxb.) Benth.	34.8	4.40	31.4	4.88	50.8	6.92	46.4	7.37
40	*Raphia hookeri* G. Mann & H.Wendl.	12.6	1.59	10.8	1.68	15.4	2.10	15.4	2.45
41	*Raphia vinifera* P.Beauv.	6.0	0.76	6.0	0.93	14.4	1.96	14.4	2.29
42	*Senna siamea* (Lam.) Irwin et Barneby	2.8	0.35	2.8	0.44	0.0	0.00	0.0	0.00
43	*Setaria pumila* (Poir.) Roem. & Schult.	50.4	6.37	28.6	4.44	94.8	12.92	83.0	13.19
44	*Sida acuta* Burm.f.	30.6	3.87	26.8	4.16	0.0	0.00	0.0	0.00
45	*Smilax aspera* L.	14.0	1.77	11.2	1.74	0.0	0.00	0.0	0.00
46	*Syngonium podophyllum* Schott	10.0	1.26	0.0	0.00	0.0	0.00	0.0	0.00
47	*Tectona grandis* L.f.	0.0	0.00	0.0	0.00	1.0	0.14	1.0	0.16
48	*Thalia geniculata* L.	26.0	3.29	24.2	3.76	0.0	0.00	0.0	0.00

Table 5: Species Importance Value Index

S/N	Species	Kpite		Eliozu	
		Wet	Dry	Wet	Dry
1	*Ageratum conyzoides* L.	6.6	6.9	0.0	0.0
2	*Alchornea cordifolia* Müll.Arg.	6.0	6.1	10.4	11.3
3	*Alchornea laxifolia* (Benth.) Pax & K Hoffm.	3.5	3.7	0.0	0.0
4	*Alstonia boonei* De Wild	2.5	2.8	2.4	2.5
5	*Alternanthera philoxeroides* (Mart.) Griseb.	10.0	10.5	12.8	12.7
6	*Ambrosia artemisiifolia* L.	7.1	7.7	0.0	0.0
7	*Anthocleista djalonensis* A Chev.	2.7	3.1	0.0	0.0
8	*Anthocleista grandiflora* L.	3.7	4.3	3.5	3.7
9	*Anthocleista vogelii* Planch.	3.6	4.2	3.6	3.7
10	*Axonopus compressus* (Sw.) P.Beauv.	0.0	0.0	12.1	11.9
11	*Bambusa vulgaris* Schrad. ex J.C.Wendl.	2.4	4.0	3.2	4.4
12	*Chromolaena odorata* (L.) R. King & H. Robinson).	9.8	10.4	0.0	0.0

13	*Cleistopholis patens* (Benth.) Engl. & Diels	2.6	3.0	0.0	0.0
14	*Commelina communis* L.	7.1	7.6	0.0	0.0
15	*Commelina latifolia* Hochst. ex A. Rich.	6.7	6.6	12.4	13.0
16	*Cordyline fruticosa* (L.) A.Chev.	6.9	0.0	0.0	0.0
17	*Costus afer* Ker-Gawl	5.0	6.9	0.0	0.0
18	*Cyperus rotundus* L.	10.6	10.0	13.4	12.5
19	*Cyperus Strigosus* L.	13.1	13.4	16.3	14.9
20	*Dieffenbachia seguine* (Jacq.) Schott	2.2	0.0	0.0	0.0
21	*Elaeis guineensis* Jacq.	4.1	3.8	0.0	0.0
22	*Emilia sonchifolia* (L.) DC. ex Wight.	10.9	11.5	14.1	13.5
23	*Euphorbia hirta* L.	4.0	3.6	12.1	11.8
24	*Ipomea involucrata* P.Beauv.	0.0	0.0	12.1	11.8
25	*Kyllinga brevifolia* Rottb.	10.2	10.4	15.2	13.7
26	*Manihot esculentum* Crantz.	13.3	20.7	0.0	0.0
27	*Mikania scandens* B.L.Rob.	5.8	0.0	0.0	0.0
28	*Musa paradisiaca* L.	4.9	6.3	0.0	0.0
29	*Musanga cecropioides* R.Br. & Tedlie	2.9	2.7	2.4	2.5
30	*Nephrolepis biserrata* (Sw.) Schott.	11.1	4.7	21.2	0.0
31	*Nymphaea lotus* L.	4.7	5.6	0.0	0.0
32	*Panicum maximum* Jacq.	6.6	7.5	11.4	11.2
33	*Peltandra virginica* (L.) Schott.	7.9	8.3	13.0	13.6
34	*Pentaclethra macrophylla* Benth.	1.8	2.0	0.0	0.0
35	*Phyllanthus amarus* Schumach. & Thonn.	9.1	6.4	9.0	7.2
36	*Phyllanthus urinaria* L.	10.1	10.8	8.6	8.7
37	*Phytolacca americana* L.	3.7	5.5	0.0	0.0
38	*Pteridium aquilinum* (L.) Kuhn	9.0	8.4	22.5	20.1
39	*Pueraria phaseoloides* (Roxb.) Benth.	10.8	12.0	17.8	19.1
40	*Raphia hookeri* G.Mann & H.Wendl.	5.8	5.9	8.8	9.5
41	*Raphia vinifera* P.Beauv.	4.3	4.9	8.5	9.2
42	*Senna siamea* (Lam.) Irwin et Barneby	2.2	2.6	0.0	0.0
43	*Setaria pumila* (Poir.) Roem. & Schult.	14.3	11.2	28.9	29.3
44	*Sida acuta* Burm.f.	9.9	10.7	0.0	0.0
45	*Smilax aspera* L.	6.4	6.5	0.0	0.0
46	*Syngonium podophyllum* Schott	4.9	0.0	0.0	0.0
47	*Tectona grandis* L.f.	0.0	0.0	2.4	2.5
48	*Thalia geniculata* L.	8.8	10.0	0.0	0.0

Table 6: Species diversity, Richness and Evenness of Kpite and Eliozu wetlands

Species Index	Kpite		Eliozu	
	Wet	Dry	Wet	Dry
Species Diversity	3.5	3.4	2.9	2.9
Species Richness	5.3	4.9	3.1	3.0
Species Evenness	0.9	0.9	0.9	0.9

Discussion

Naturally, wetlands support diverse species. However, ecosystem perturbations through various human activities results in species composition reduction and vegetation structure alteration in time and space (Agbelade & Onyekwelu, 2020; Ugwuzor *et al*., 2022). As a major threat factor which may result in ecosystem degradation and extinction of species, ecosystem perturbation results from human activities (Cowie *et al*., 2022; Storch *et al*., 2022). This fact is corroborated by the findings of this study as findings revealed lower species composition at Eliozu freshwater swamp located within an urban environment compared with Kpite freshwater wetland located in a rural setting. The explanation for the reduction in species content recorded at Eliozu site could have been the impact of diverse human activities going on in the area because of its location in an urban environment and the consequent impacts of the activities on the ecosystem. This site is exposed to numerous human interference such as pollution from petroleum hydrocarbon, waste disposal, repeated crop farming and land reclamation. This result corresponds with the findings of Abd El-Wahab (2016); Neji *et al*. (2018); Moses (2012). According to Moses (2012) human factors such as lack of awareness of conservation of wetland by local people and political factors in which the rich are granted free access to wetland natural resources led to wetland ecosystem destruction of Wakiso District, Uganda.

Species frequency is a measure of distribution. A low species frequency indicates that species is either irregularly distributed or rare in an area. The higher species frequency at Kpite indicates that its species are more evenly distributed than those of Eliozu site. Naturally, regular distribution of species in an environment is the result of stable ecosystem that is free from perturbation. Therefore, the higher species frequency could have resulted due to limited human interference in ecosystem processes. It could also have been the result of limited human perturbations such as optimum harvest of ecosystem resources, absence of ecosystem destruction by fire and pollution incidences in the area. The significance of stable ecosystem is uninhibited seeds germination, normal growth and survival of species. With a stable ecosystem, species express their biotic potential in their environment. With the Eliozu site exposed to many disturbances because of its location in an urban area, the potentials of some species to grow freely at every microplot of the area may have been negatively affected and these could be responsible for the observed low species frequency of the area. Similarly, species abundance and density were lower at Eliozu freshwater. These species indices in any plant community are influenced by species growth behaviour, light, edaphic characteristics and most importantly ecosystem disturbances. Low species abundance and density at Eliozu freshwater site can be attributed to human interferences in ecosystem stability.

The species diversity of Kpite was higher than that of Eliozu. The difference in species diversity in the two ecosystems is understood as the lower species diversity of Eliozu site can be may be attributed to the various anthropogenic activities in the area. They could also result from the effects of pollution on species as Eliozu freshwater swamp, for being located in urban setting, is exposed to grazing, discharge of petroleum hydrocarbon products and waste substances from homes and the industries around (Cantonati *et al*., 2020; Sage, 2020; Atiim *et al*., 2022). Some of the waste materials have toxic effects on species and therefore could negatively affect the survival of some plant species. Conversely, this is not the case for Kpite site which is located in a rural environment where there is greater prevalence of natural processes and less of toxic wastes generation and release into the swamp. Furthermore, higher diversity was also recorded during the wet season compared to dry season. This corroborates the work of Gojamme (2013) who reported higher diversity during wet season. This justifies the notion that high rainfall during the wet season favours the establishment, growth and proliferation of many plant species.

Plant species observed at Kpite wetland have higher species richness and evenness compared to Eliozu wetland. Tropical studies have linked the importance of moisture and other factors to species richness (Hagen *et al*., 2021). Changes in species richness pattern are controlled by factors such as local environmental variables which include temperature, precipitation, seasonality, disturbance regimes, edaphic characteristics.

CONCLUSION

The study revealed variation in plant species composition and diversity in Eliozu (urban) and Kpite (rural) freshwater wetlands. These variations arose as a result of anthropogenic perturbations. Higher species composition and diversity were recorded at Kpite freshwater wetlands compared to Eliozu freshwater wetland. Thus, the findings highlight the significance of social setting and anthropogenic activities on wetlands. However, implementation of conservation measures is important for preservation and maintenance of Eliozu freshwater wetland is recommended. Also, regular floristic and diversity assessments are suggested for the protection, management and conservation of wetlands.

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