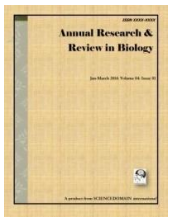

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Phytodiversity Assessment in Abandoned Solid Waste Dumpsites in Port Harcourt, Nigeria

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Authors' contributions

This work was carried out in collaboration between both authors. Authors TNEM and FBGT designed the study, carried out the field and gather data, wrote the protocol and interpreted the data, performed preliminary data analysis together. Author TNEM managed the literature searches and produced the initial draft. Both authors read and approved the final manuscript.

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ABSTRACT

Aim: Assessments of phytodiversity at two abandoned solid waste dumpsites in Port Harcourt, Nigeria.
Study Design: A systematic sampling approach comprising three line-transects of 5 m and 10 m interval was used.
Methodology: At each of the sites, an area of 15 m x 30 m was measured and demarcated. A total of nine 2 m x 2 m sample plots located along transects were used for the study. The species found at each sample plot were identified and counted.
Place and Duration of Study: The study was conducted at Alakahia and Eastern-Bypass dumpsite, Port Harcourt alongside their controls in August, 2013.
Results: The total number of species found at Alakahia (site 1) was 36 species with 28 species found at the dumpsite and 17 species found at the control site. Eastern by-pass (site 2) presented a total of 38 species, with the dumpsite having a total of 29 species while the control site had a total of 26 species. 21 plant families were found at site1; and site 2 had 25 plant families. The family with the highest number of species was Poaceae. The dumpsites had higher species diversity than the

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control. The control site had higher frequency of species occurrence than the dumpsite. *Chromolaena odorata* and *Luffa aegyptiaca* were dominant at the dumpsites while the dominant species at the control site was *Eleusine indica*. Density of the species was also higher at the dumpsites compared to the control.
Conclusion: Solid waste dumpsites altered and favoured the growth of diverse species.

Keywords: Species diversity; solid waste; dumpsites; frequency of occurrence; abundance.

1. INTRODUCTION

One of the greatest problems the world is facing today is that of environmental pollution, which is the release of harmful or unfavorable materials into the environment through natural or anthropogenic (man-made) sources that alters the physical, chemical and biological conditions of the environment. Man has become capable of altering his physical environment to suit himself and change the earth's surface at a much faster rate than many of the natural processes [1]. Although the object of these alterations was to improve his living conditions, in some cases they have created major long-term problems that are catastrophic both for the natural environment and him. The increase in demand for resources required by man for his existence is a result of the rapid increase in human population which leads to overexploitation of natural resources, deforestation, extensive use of chemical fertilizers and pesticides which leads to increase in waste generation and pollution as a result of improper management.

Pollution arises from different sources like improper solid waste disposal which is generated from human activities. Solid wastes are unwanted or discarded solid materials from residential, commercial, industrial, mining, and agricultural activities which may cause environmental, social and health problems if not properly handled [2]. The impact of solid waste in the environment may cause grave consequences as it could lead to land, air and water pollution. Solid waste is made up of leaf litters, spoilt farm produce or machineries, animal droppings, dead animals, post harvest waste, manure, farm plastics, waste tires, scrap metals, latex paints, furniture, toys, domestic refuse (garbage), discarded appliances, empty cans, cylinders, construction materials, demolition debris, etc [3]. The proper disposal and management of these waste is a challenge faced in the agricultural sector.

Solid waste may pollute the environment through the release of substances such as heavy metals, which in large quantities interfere with the physiological activities of plants such as photosynthesis, gaseous exchange and nutrient absorption and cause reduction in plant growth, dry matter accumulation and yield [4]. Plants absorb these metals which disrupts the natural processes of plant metabolism. When agricultural soils are polluted, these heavy metals are taken up by plants and consequently accumulate in their tissues [5]. The richness of species in a community depends on the quality of the soil which can either favour the growth of the species or alter the natural metabolism of the plants in the community. Diversity of vegetation is directly influenced by soil characteristics. Solid waste pollutants serve as an external force affecting the physico-chemical characteristics of soil ultimately contributing towards the poor production of vegetation [6]. On the other, waste materials and materials derived from wastes, possess many characteristics that can improve soil fertility and enhance crop performance. For example, application of composted municipal solid waste and composted crop residues were shown to increase soil fertility and improve structural stability in agricultural soils [7]. Elevated nitrogen content favours fast-growing grass species which is often desirable for reclamation and revegetation projects [8]. However, the dominance of grasses can lead to competitive exclusion of herb species and can initiate a strong decline in plant species richness [9]. Various studies have shown that dumpsite soils in south-eastern Nigeria and other parts of the country support plants growth and biodiversity and because of that they have been extensively used for cultivating varieties of edible vegetables and plant based foodstuff [10-13]. These practices pose serious health and environmental concern due to the anthropogenic contamination of these waste soils with intolerable level of chemical materials [14,15].

The indiscriminate disposal of solid waste is a menace that needs to be addressed in order to mitigate the adverse effect it has on humans, plants and animals, hence this research is carried out to determine the impact of solid waste

on plant species composition and diversity. It is expected that results obtained will improve the existing knowledge of the impact of pollution especially land pollution on species diversity.

2. MATERIALS AND METHODS

This study was carried out in August, 2013 at two abandoned solid waste dumpsites over taken by plants and two nearby sites with no contact with the refuse (control), located at Alakahia axis of East-west road and Eastern by pass, Trans-Amadi both in Port Harcourt, Rivers state, Nigeria. The climate of Port Harcourt is characterized by high temperature (above 25ºC), high relative humidity (60%) and high rainfall (above 2000 mm/yr).

The dumpsite on East-west road, designated as site 1 is located at geographical coordinates of latitude 4.88774ºN and longitude 6.92296ºE and the control site is on the other side of the road with latitude 4.88778ºN and longitude 6.92272ºE. The Eastern by-Pass, designated as site 2 is located at geographical coordinates of latitude 4.729281ºN and longitude 7.01638ºE and the control site is at latitude 4.79078ºN and longitude 7.01782ºE (Fig. 1)

The starting point (10 meters away from the road) was cleared using a cutlass and marked with a carved wooden peg. Then the field was slightly cleared to create a footpath. At each of the dumpsite and control, a study site of 15 m x 30 m was measured with a measuring tape, demarcated with wooden pegs and rope. A systematic sampling approach comprising three (3) line-transects of 5 m intervals was used. Within each of the line transect, three (3) sample plots of 10 m interval were located. A total of nine (9) sample plots were used for the exercise in each study site. Each sample plot was 2 m x 2 m and was demarcated with pegs and ropes. Plant species in each of the sample plots were identified by their scientific names, counted and recorded and grouped according to their families. The species that could not be identified on site were cut using scissors, labeled alphabetically with masking tape and biro, put in a black nylon bag, labeled and taken to the University of Port Harcourt Herbarium for immediate and proper identification while the plants were still fresh.

The following quantitative data of the vegetation in both the dumpsites and control in the two (2) locations were taken: frequency of occurrence, Abundance, Density, species diversity and evenness. All of them were calculated according to Anyanwu et al. [16].

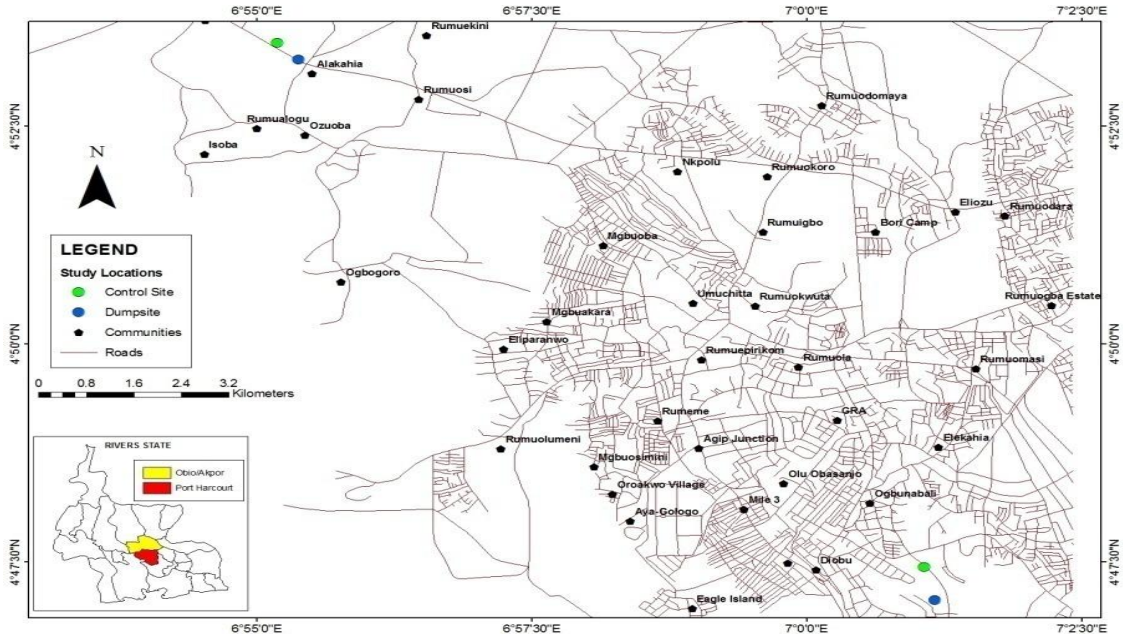

Fig. 1. Map of study area

The frequency of occurrence of each species was calculated using the formula;

$$\text{Frequency (\%)} = \frac{\text{Total no. of sample plots in which the species occur}}{\text{Total no. of sample plots studied}} \times 100\%$$

The abundance of each of the species was calculated per unit area with the formula;

$$\text{Abundance } (m^{-2}) = \frac{\text{Total no. of Individuals of the Species in all the Sample Units}}{\text{Total no. of Sampling Unit in which the Species Occurred}}$$

The density for each of the species was calculated per unit area using the formula;

$$\text{Density } (m^{-2}) = \frac{\text{Total no. of Individuals of the Species in all the Sample Units}}{\text{Total no. of Sampling Unit studied}}$$

Species diversity index was calculated using Shannon-Wiener (1949) diversity index (H) formula (cited from Anyanwu et al. [16]);

$$H = -\sum[Pi(\log Pi)],$$

Where Pi = ni/N, ni is the number of individuals of the ith species and N is the total number of individuals for all species.

Pileou species evenness index (E) was calculated using the formula;

$$E = H/\log S$$

Where H is Shannon-Wiener's index and S is the number of species.

3. RESULTS

The result on species composition studies at the abandoned solid waste dumpsites and control sites are presented in Table 1. It was observed that the dumpsites presented higher number of species than the control sites. The total number of species found at Alakahia (site 1) was 36 species with 28 species found at the dumpsite and 17 species found at the control site respectively and Eastern by pass (site 2) had a total of 38 species, with the dumpsite having a total of 29 species while the control site had a total of 26 species. The species dominant at the dumpsite of site 1 were *Chromolaena odorata* and *Luffa aegyptiaca* and; the species sparsely present were *Carica papaya* and *Ludwigia decurrens* while the species dominant at the control site of site 1 were *Ipomoea involucrata* and *Aspilia africana* and the species sparsely present were *Millettia thonningii, Combretum hispidum* and *Triumfetta cordifolia.* The species dominant at the dumpsite of site 2 was *Luffa aegyptiaca* and the species sparsely populated was *Centrosema pubescens* while the dominant species at the control site was *Eleusine indica* and the sparsely populated species were *Canna indica* and *Cassia alata.*

It was also observed that the sites were characterized by herbaceous plants, with few grasses, trees, climbers and shrubs. The family Poaceae was dominant having the highest number of species at the dumpsites and control sites of both sites. The dumpsites showed higher level of species diversity and the control sites showed more species evenness.

The result also showed that species such as *Chromolaena odorata, Panicum maximum, Mimosa pudica, Centrosema pubescens, Ipomoea involucrata, Eleusine indica, Cynodon dactylon*, *Cyathula prostrata* and *Aspilia africana* were common to both the dumpsite and control site at site 1 while species common to both the dumpsite and control site at site 2 were; *Luffa aegyptiaca, Solanum torvum, Panicum maximum, Centrosema pubescens, Asystasia gangetica, Eleusine indica, Synedrella nodiflora, Phyllanthus amarus, Cynodon plectostachyus, Alternanthera sessiliss, Aspilia africana, Chromolaena odorata, Stachytarpeta jamaicensis, Sida acuta, Mimosa pudica and Kyllinga* sp.

Table 2 showed the frequency of occurrence for the control and dumpsites for both Alakahia (site1) and Eastern by pass (site 2). Frequency of occurrence of the species was higher at the control site than at the dumpsite of both site 1 and site 2. The results showed that the *Luffa aegyptiaca* had the highest percentage frequency of occurrence at the dump site 1 and *Ipomoea involucrata* had the highest percentage frequency of occurrence at the control site of site 1. It was also observed that *Panicum maximum*

and *Solanum torvum* had the highest percentage frequency of occurrence at the control site of site 2 while *Luffa aegyptiaca* had the highest percentage frequency of occurrence at the dumpsite of site 2. *Cyathula prostrata* recorded equal percentage frequency of occurrence in both the control and dumpsite plot in Alakahia. *Peperomia pellucida, Cynodon dactylon* and *Laportea aestuans* had equal percentage frequency of occurrence at the two dumpsites.

Table 3 showed the abundance of species at the dumpsite and control sites of Alakahia (site 1) and Eastern by pass (site 2). The results showed that the abundance of the species was higher at the dumpsite than the control site of both site 1 and site 2. It was observed that certain species were found to be associated with both the dumpsites and control site at site 1; such as *Chromolaena odorata, Panicum maximum, Mimosa pudica, Centrosema pubescens, Ipomoea involucrata, Eleusine indica, Cynodon dactylon, Cyathula prostrata* and *Aspilia africana* and some species were also common in all the dumpsite and control site of site 2 such as: *Chromolaena odorata, Luffa aegyptiaca, Synedrella nodiflora, Panicum maximum, Mimosa pudica, Centrosema pubescens, Eleusine indica, Phyllanthus amarus, Aspilia africana, Cynodon plectostachycus, Sida acuta, Commelina erecta, Solanum torvum, Asystasia gangetica, Alternanthera sessilis, Stachytarpeta jamaicensis* and *Kyllinga* sp. The results also showed that the dumpsite at site 1(Alakahia) had the highest abundance of species and *Aspilia africana* was more abundant than other species at the control site of site 1 while *Cynodon dactylon* was more abundant at the dumpsite of site 1. The control site and dumpsite of site 2 were dominated by *Kyllinga* sp.

Table 4 showed the density of species at the control and dumpsite of site 1(Alakahia) and site 2 (Eastern by pass). It was observed that the density of species at the dumpsite was higher than the control site of both sites 1 and 2. The results also showed that control at site 1 was densely populated with *Chromolaena odorata, Ipomoea involucrata* and *Aspilia africana* while the dumpsite of site 1 was only densely populated by *Chromolaena odorata. Panicum maximum* and *Eleusine indica* were the densely populated species at the control site at site 2 while *Luffa aegyptiaca* had the highest density in the dumpsite at site 2.

4. DISCUSSION

The abandoned solid waste dumpsites had a higher level of species diversity than the control sites which had no contact with refuse. This could be attributed to the availability of some nutrient for plants which could have been added to the soil from the decomposition of the components of the solid waste dumped at the site. This is true since the composition of most solid wastes have high organic matter content which could decompose and add nutrients to the soil. The dumpsites were characterized by herbaceous plants with a bit of shrubs, trees, climbers and grasses. This is in line with Obute et al. [17] who stated that herbaceous species were the most frequent in abandoned solid waste dumpsites. It is also possible that solid wastes may contain some viable dormant seeds of different species which when disposed at the dumpsite germinate and grow with other species presence; thereby increasing the phytodiversity as recorded in the dumpsites. The control sites had more evenly spread species than the dumpsites.

Table 1. Species content and diversity at alakahia (site 1) and eastern by pass (site 2) with their respective control

S/no	Species	Family	Habit	Control site 1	Dump site 1	Control site 2	Dump site 2
1	*Chromolaena odorata*	Asteraceae	Shrub	58	94	35	11
2	*Luffa aegyptiaca*	Cucurbitaceae	Climber	-	88	5	112
3	*Aframomum melegueta*	Zingiberaceae	Herb	-	14	-	-
4	*Carica papaya*	Caricaceae	Tree	-	1	-	-
5	*Synedrella nodiflora*	Asteraceae	Herb	-	52	17	12
6	*Panicum maximum*	Poaceae	Grass	27	48	61	64
7	*Mimosa pudica*	Fabaceae	Shrub	34	22	32	7
8	*Hypoestes* Sp	Acanthaceae	Herb	-	19	-	-
9	*Centrosema pubescens*	Fabaceae	Herb	32	36	39	2
10	*Ipomoea involucrate*	Convolvulaceae	Herb	59	11	6	-

S/no	Species	Family	Habit	Control site 1	Dump site 1	Control site 2	Dump site 2
11	*Ageratum conyzoides*	Asteraceae	Herb	-	2	-	-
12	*Eleusine indica*	Poaceae	Grass	49	10	62	78
13	*Ludwigia decurrens*	Onagraceae	Herb	-	1	-	-
14	*Echinchloa colona*	Poaceae	Grass	-	9	7	-
15	*Spermacoce ocymoides*	Rubiaceae	Herb	-	13	-	-
16	*Cynodon dactylon*	Poaceae	Grass	13	15	-	15
17	*Physalis micrantha*	Solanaceae	Herb	-	10	-	-
18	*Hibiscus* Sp	Malvaceae	Shrub	-	7	-	-
19	*Ipomoea aquatic*	Convolvulaceae	Herb	-	10	-	-
20	*Phyllanthus amarus*	Phyllanthaceae	Herb	-	12	10	63
21	*Laportea aestuans*	Urticaceae	Herb	-	9	-	7
22	*Cyathula prostrate*	Amaranthaceae	Herb	9	10	-	-
23	*Setaria barbata*	Poaceae	Herb	-	14	-	-
24	*Peperomia pellucid*	Piperaceae	Herb	-	13	-	9
25	*Talinum triangulare*	Portulacaceae	Herb	-	4	-	-
26	*Aspilia Africana*	Asteraceae	Herb	59	3	13	18
27	*Emilia sonchifolia*	Asteraceae	Herb	-	15	-	-
28	*Cynodon plectostachyus*	Poaceae	Grass	-	8	12	22
29	*Pueraria phaseoloides*	Fabaceae	Herb	46	-	-	-
30	*Combretum* Sp	Combretaceae	Climber	19	-	-	-
31	*Sida acuta*	Malvaceae	Herb	23	-	38	13
32	*Commelina erecta*	Commelinaceae	Herb	52	-	15	8
33	*Manihot esculenta*	Euphorbiaceae	Shrub	9	-	-	-
34	*Millettia thonningii*	Fabaceae	Tree	3	-	-	-
35	*Combretum hispidum*	Combretaceae	Climber	3	-	-	-
36	*Triumfetta cordifolia*	Tiliaceae	Shrub	3	-	30	-
37	*Solanum torvum*	Solanaceae	Shrub	-	-	18	32
38	*Diodia sarmentosa*	Rubiaceae	Herb	-	-	-	7
39	*Asystasia gangetica*	Acanthaceae	Herb	-	-	4	11
40	*Heterotis rotundifolia*	Melastomataceae	Herb	-	-	-	16
41	*Acalypa* sp	Euphorbiaceae	Herb	-	-	-	33
42	*Vernonia amygladina*	Asteraceae	Shrub	-	-	-	3
43	*Alternanthera sessilis*	Amaranthaceae	Herb	-	-	12	22
44	*Stachytarpeta jamaicensis*	Verbanaceae	Shrub	-	-	43	5
45	*Solenostenom monostachyus*	Lamiaceae	Herb	-	-	-	27
46	*Euphorbia heterophylla*	Euphorbiaceae	Herb	-	-	-	4
47	*Passiflora foetida*	Passifloraceae	Herb	-	-	-	22
48	*Kyllinga* sp	Cyperaceae	Grass	-	-	23	20
49	*Pouzolzia guineensis*	Urticaceae	Herb	-	-	-	12
50	*Desmodium scorpiurus*	Papilionoideae	Herb	-	-	-	9
51	*Hyptis suaveolens*	Lamiaceae	Shrub	-	-	4	-
52	*Senna hirsute*	Caesalpiniodeae	Shrub	-	-	11	-
53	*Cassia alata*	Caesalpiniodeae	Shrub	-	-	2	-
54	*Xanthosoma* sp	Araceae	Herb	-	-	3	-
55	*Triumfetta rhomboidea*	Tiliaceae	Shrub	-	-	4	-
56	*Canna indica*	Cannaceae	Herb	-	-	2	-
	Total			498	550	508	664
	Species diversity			1.106	1.224	1.262	1.278
	Species evenness			0.899	0.846	0.892	0.874

Table 2. Frequency of species content at alakahia (site 1) and eastern by pass (site 2) with their controls

S/no.	Species	Control site1	Dump site 1	Control 2	Dump site 2
1	*Chromolaena odorata*	88.9	77.8	77.8	33.3
2	*Luffa aegyptiaca*	-	100	33.3	88.9
3	*Aframomum melegueta*	-	11.1	-	-
4	*Carica papaya*	-	11.1	-	-
5	*Synedrella nodiflora*	-	55.6	11.1	22.2
6	*Panicum maximum*	66.7	55.6	88.9	77.8
7	*Mimosa pudica*	55.6	22.2	4.44	11.1
8	*Hypoestes* Sp	-	22.2	-	-
9	*Centrosema pubescens*	66.7	44.4	55.6	11.1
10	*Ipomoea involucrate*	100	22.2	33.3	-
11	*Ageratum conyzoides*	-	11.1	-	-
12	*Eleusine indica*	66.7	11.1	44.4	77.8
13	*Ludwigia decurrens*	-	11.1	-	-
14	*Echinchloa colona*	-	11.1	11.1	-
15	*Spermacoce ocymoides*	-	11.1	-	-
16	*Cynodon dactylon*	22.2	11.1	-	11.1
17	*Physalis micrantha*	-	11.1	-	-
18	*Hibiscus* Sp	-	11.1	-	-
19	*Ipomoea aquatic*	-	11.1	-	-
20	*Phyllanthus amarus*	-	11.1	11.1	55.6
21	*Laportea aestuans*	-	11.1	-	11.1
22	*Cyathula prostrate*	11.1	11.1	-	-
23	*Setaria barbata*	-	11.1	-	-
24	*Peperomia pellucid*	-	11.1	-	11.1
25	*Talinum triangulare*	-	11.1		
26	*Aspilia Africana*	66.7	11.1	33.3	22.2
27	*Emilia sonchifolia*	-	22.2		
28	*Cynodon plectostachyus*	-	11.1	11.1	22.2
29	*Pueraria phaseoloides*	55.6	-	-	-
30	*Combretum* Sp	55.6	-	-	-
31	*Sida acuta*	55.6	-	77.8	33.3
32	*Commelina erecta*	66.7	-	55.6	11.1
33	*Manihot esculenta*	55.6	-	-	-
34	*Millettia thonningii*	11.1	-	-	-
35	*Combretum hispidum*	11.1	-	-	-
36	*Triumfetta cordifolia*	11.1	-	55.6	-
37	*Solanum torvum*	-	-	88.9	55.6
38	*Diodia sarmentosa*	-	-	-	11.1
39	*Asystasia gangetica*	-	-	11.1	11.1
40	*Heterotis rotundifolia*	-	-	-	22.2
41	*Acalypa* sp	-	-	-	77.8
42	*Vernonia amygladina*	-	-	-	11.1
43	*Alternanthera sessilis*	-	-	11.1	22.2
44	*Stachytarpeta jamaicensis*	-	-	55.6	11.1
45	*Solenostenom monostachyus*	-	-	-	33.3
46	*Euphorbia heterophylla*	-	-	-	33.3
47	*Passiflora foetida*	-	-	-	22.2
48	*Kyllinga* sp	-	-	4.1	11.1
49	*Pouzolzia guineensis*	-	-	-	11.1
50	*Desmodium scorpiurus*	-	-	-	11.1
51	*Hyptis suaveolens*	-	-	11.1	-
52	*Senna hirsute*	-	-	22.2	-
53	*Cassia alata*	-	-	22.2	-
54	*Xanthosoma* sp	-	-	11.1	-
55	*Triumfetta rhomboidea*	-	-	11.1	-
56	*Canna indica*	-	-	11.1	-

Table 3. Abundance of species content at alakahia (site 1) and eastern by- pass (site 2)

S/no.	Species	Control site 1	Dumpsite 1	Control site 2	Dump site 2
1	*Chromolaena odorata*	1.8	3.4	1.3	0.9
2	*Luffa aegyptiaca*	-	2.4	0.4	3.5
3	*Aframomum melegueta*	-	3.5	-	-
4	*Carica papaya*	-	0.3	-	-
5	*Synedrella nodiflora*	-	2.6	4.3	1.5
6	*Panicum maximum*	1.1	2.4	1.9	2.3
7	*Mimosa pudica*	1.7	2.8	2.0	1.8
8	*Hypoestes* Sp	-	2.4	-	-
9	*Centrosema pubescens*	1.3	2.3	2.0	0.5
10	*Ipomoea involucrate*	1.6	1.4	0.5	-
11	*Ageratum conyzoides*	-	0.5	-	-
12	*Eleusine indica*	2.0	2.5	3.9	2.8
13	*Ludwigia decurrens*	-	0.3	-	-
14	*Echinchloa colona*	-	2.3	1.8	-
15	*Spermacoce ocymoides*	-	3.3	-	-
16	*Cynodon dactylon*	1.6	3.8	-	3.8
17	*Physalis micrantha*	-	2.5	-	-
18	*Hibiscus* Sp	-	1.8	-	-
19	*Ipomoea aquatic*	-	2.5	-	-
20	*Phyllanthus amarus*	-	3.0	2.5	3.2
21	*Laportea aestuans*	-	2.3	-	1.8
22	*Cyathula prostrate*	2.3	2.5	-	-
23	*Setaria barbarta*	-	3.5	-	-
24	*Peperomia pellucid*	-	3.3	-	2.3
25	*Talinum triangulare*	-	1.0		
26	*Aspilia Africana*	2.5	0.8	1.1	2.3
27	*Emilia sonchifolia*	-	1.9		
28	*Cynodon plectostachycus*	-	2.0	3.0	2.8
29	*Pueraria phaseoloides*	2.3	-	-	-
30	*Combretum* Sp	1.0	-	-	-
31	*Sida acuta*	1.2	-	1.4	1.1
32	*Commelina erecta*	2.2	-	1.9	2.0
33	*Manihot esculenta*	0.5	-	-	-
34	*Millettia thonningii*	0.8	-	-	-
35	*Combretum hispidum*	0.8	-	-	-
36	*Triumfetta cordifolia*	0.8	-	1.5	-
37	*Solanum torvum*	-	-	0.6	1.6
38	*Diodia sarmentosa*	-	-	-	1.8
39	*Asystasia gangetica*	-	-	1.0	2.8
40	*Heterotis rotundifolia*	-	-	-	2.0
41	*Acalypa* sp	-	-	-	1.2
42	*Vernonia amygladina*	-	-	-	0.8
43	*Alternanthera sessilis*	-	-	3.0	2.8
44	*Stachytarpeta jamaicensis*	-	-	2.2	1.3
45	*Solenostenom monostachyus*	-	-	-	2.3
46	*Euphorbia heterophylla*	-	-	-	1.0
47	*Passiflora foetida*	-	-	-	2.8
48	*Kyllinga* sp	-	-	5.8	5.0
49	*Pouzolzia guineensis*	-	-	-	3.0
50	*Desmodium scorpiurus*	-	-	-	2.3
51	*Hyptis suaveolens*	-	-	1.0	-
52	*Senna hirsute*	-	-	1.4	-
53	*Cassia alata*	-	-	0.3	-
54	*Xanthosoma* sp	-	-	0.8	-
55	*Triumfetta rhomboidea*	-	-	1.0	-
56	*Canna indica*	-	-	0.5	-

Table 4. Density of species content at alakahia (site 1) and eastern by-pass (site 2)

S/no.	Species	Control site 1	Dumpsite 1	Control site 2	Dumpsite 2
1	*Chromolaena odorata*	1.6	2.6	1.0	0.3
2	*Luffa aegyptiaca*	-	2.4	0.1	3.1
3	*Aframomum melegueta*	-	0.4	-	-
4	*Carica papaya*	-	0.03	-	-
5	*Synedrella nodiflora*	-	1.4	0.5	0.3
6	*Panicum maximum*	0.8	1.3	1.7	1.8
7	*Mimosa pudica*	0.9	0.6	0.9	0.2
8	*Hypoestes* Sp	-	0.5	-	-
9	*Centrosema pubescens*	0.9	1.0	1.1	0.1
10	*Ipomoea involucrate*	1.6	0.3	0.2	-
11	*Ageratum conyzoides*	-	0.1	-	-
12	*Eleusine indica*	1.4	0.3	1.7	2.2
13	*Ludwigia decurrens*	-	0.03	-	-
14	*Echinchloa colona*	-	0.3	0.2	-
15	*Spermacoce ocymoides*	-	0.4	-	-
16	*Cynodon dactylon*	0.4	0.4	-	0.4
17	*Physalis micrantha*	-	0.3	-	-
18	*Hibiscus* Sp	-	0.2	-	-
19	*Ipomoea aquatic*	-	0.3	-	-
20	*Phyllanthus amarus*	-	0.3	0.3	1.8
21	*Laportea aestuans*	-	0.3	-	0.2
22	*Cyathula prostrate*	0.3	0.3	-	-
23	*Setaria barbarta*	-	0.4	-	-
24	*Peperomia pellucid*	-	0.4	-	0.3
25	*Talinum triangulare*	-	0.1		
26	*Aspilia Africana*	1.6	0.1	0.4	0.5
27	*Emilia sonchifolia*	-	0.4		
28	*Cynodon plectostachycus*	-	0.2	0.3	0.6
29	*Pueraria phaseoloides*	1.3	-	-	-
30	*Combretum* Sp	0.5	-	-	-
31	*Sida acuta*	0.6	-	1.1	0.4
32	*Commelina erecta*	1.4	-	0.4	0.2
33	*Manihot esculenta*	0.3	-	-	-
34	*Millettia thonningii*	0.1	-	-	-
35	*Combretum hispidum*	0.1	-	-	-
36	*Triumfetta cordifolia*	0.1	-	0.8	-
37	*Solanum torvum*	-	-	0.5	0.9
38	*Diodia sarmentosa*	-	-	-	0.2
39	*Asystasia gangetica*	-	-	0.1	0.3
40	*Heterotis rotundifolia*	-	-	-	0.4
41	*Acalypa* sp	-	-	-	0.9
42	*Vernonia amygladina*	-	-	-	0.1
43	*Alternanthera sessilis*	-	-	0.3	0.6
44	*Stachytarpeta jamaicensis*	-	-	1.2	0.1
45	*Solenostenom monostachyus*	-	-	-	0.8
46	*Euphorbia heterophylla*	-	-	-	0.1
47	*Passiflora foetida*	-	-	-	0.6
48	*Kyllinga* sp	-	-	0.6	0.6
49	*Pouzolzia guineensis*	-	-	-	3.0
50	*Desmodium scorpiurus*	-	-	-	0.3
51	*Hyptis suaveolens*	-	-	0.1	-
52	*Senna hirsute*	-	-	0.3	-
53	*Cassia alata*	-	-	0.1	-
54	*Xanthosoma* sp	-	-	0.1	-
55	*Triumfetta rhomboidea*	-	-	0.1	-
56	*Canna indica*	-	-	0.1	-

It could be said that the plants species found on the control site were the native species of the area which could have resulted in their higher frequency of occurrence while the solid waste favoured the growth of more alien species thereby increasing the species diversity at the dumpsite. Species such as *Luffa aegyptiaca, Ipomoea involucrata, Chromolaena odorata, Panicum maximum* and *Solanum torvum* recorded high percentage frequency of occurrence which could be attributed to their high tolerance to the nutrient mix of these sites. The species were more abundant at the dumpsites than the control sites and the density of the species was also higher at the dumpsites compared to the controls. Tripathi and Misra, [18] in their study also report that species diversity was higher at the waste accumulation sites as compared with the control sites. This is in contrast with the report by Ali et al. [19] in a study that the control sites showed diversified variety of plants i.e., 44 plant species while this number reduced to only 32 plant species at the disposal sites. Obute et al. [17] reported that dumping of refuse influenced the types of species that thrived on these abandoned dumpsites and species diversity was generally lower for the abandoned dumpsites than the control site. Obasi et al. [20] also reported that dumpsite soils in Southern Nigeria and other parts of the country supports plant growth and biodiversity. Ndukwu et al. [21] had also reported that physico-chemical changes occurred in the soils associated with refuse dumps. The alteration of the physico-chemical properties of the soil is therefore expected to affect the survival of certain species and hence their diversity.

It is possible that the solid waste dumps modified the physico-chemical characteristics of the recipient habitats leading to significant changes in the species composition of the area. This is a logical trend since only the plants that can survive in such condition will thrive to the elimination of all others. The tolerance and susceptibility of some plants to these changes in the physico-chemical parameters found in abandoned dumpsites may result to differences in species composition of the habitat.

5. CONCLUSION

This study has shown the ability of some plants species to thrive in any given situation. Uncontrolled deposition of solid waste in the environment is posing serious threat to species diversity as it gives rise to the growth of alien species that can eliminate the native species of the area. The dumpsite had more of herbaceous species and higher species diversity than the control site which indicates that the solid waste alters the requirements in the soil for plants growth and development, hence affecting phytodiversity.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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