Nigerian Journal of Soil Science

journal homepage:www.soilsjournalnigeria.com

Effect of different Slums on Selected Soil Properties in Abakaliki Southeastern Nigeria

Njoku, C. and Okoro, G.C.

Department of Soil Science and Environmental Management, Faculty of Agriculture and Natural Resources Management, Ebonyi State University, Abakaliki-Nigeria

ARTICLE INFO

Article history:
Received: 28th June, 2018
Received in revised form: 30th July, 2018
Accepted: 2nd August, 2018
Available online: 1st December 2018

Keywords:
Degradation, Improvement pollution, Sanitation, slum

Corresponding Author's email Address: chimarco2001@yahoo.com

https://doi.org/10.36265/njss.2018.280207
ISSN-1597-4488 ©publishingrealtime.

ABSTRACT

A study was conducted at Abakaliki to determine the effect of slums on soil physicochemical properties. Four replicate samples were collected from the four slum locations and control using auger and core for disturbed and undisturbed soil samples, respectively. The soil samples collected were taken to laboratory and analysed for bulk density, total porosity, mean weight diameter, aggregate stability, dispersion ratio, pH, available phosphorus, total nitrogen, organic carbon, C/N ratio, total exchangeable bases, exchangeable acidity, effective cation exchange capacity, base saturation and heavy metals (Cd, Cu, Pb and Sn). The data obtained were analyzed using analysis of variance (ANOVA) based on CRD and difference between treatment means were dictated using F-LSD. Except for dispersion ratio which is non-significant, all the parameters studied showed significant ($p < 0.05$) changes with respect to the different locations studied. The result showed lower improvement in soil physical and chemical properties in slums than control. On the other hand Cd, Cu, Pb, and Sn were higher in slums than control. Similarly, these heavy metals observed were higher than the usual range in soils. Thus, the study suggests that slum soils should not be used for crop production since they are associated with heavy metal pollutions and also lack the essential nutrients required by crop for performance

1. Introduction

Rapid urbanization influences economic growth and forces people to look for working and investment opportunities in cities such as Abakaliki. However, as shown by poor urban infrastructures and inadequate housing, the cities are unable to manage this development (Firdaus, 2012). Urban decay and degradation are caused mainly by the urbanization process. However, most of the environmental problems in slums are a result of unplanned land uses and weak development controls (Simon *et al.,* 2013).). A slum is an overcrowded and dirty zone of urban areas which is characterized by open drains, disorganized structures, and improper refuse disposal, no security of tenure, shortage of safe drinking water, lack of proper sanitation, inadequate power supply and scarce of medical and social facilities. Poverty, crime, pollutions, disease, and deprivation co-exist in these zones of urban areas (Jalota, 2016). Njoku and Okoro (2014), showed that slum dwellers do not have access to affordable land and therefore, resort to squatting and illegal settling in unauthorized lands such as access roads, nature reserves, and areas liable to floods. This condition affects both human habitation and ecological environment.

Abakaliki has been experiencing a significant population growth since the creation of the state in 1996 as a result of the influx of different parts of people from rural areas that are looking for a greener pasture. Hence, poor housing structures which are disorderly located crowded some areas and the settlement has now grown and developed in an unplanned manner resulting in the deterioration of the values of the property and social status of the estate environment (Okafor and Onuoha, 2016). Most of the slums in Abakaliki lack durable housing; have a room sharing by more than three households; have a toilet shared by a reasonable number of people and lack access to sufficient amounts of safe water. Having known that slums in the study areas are characterized by improper wastes disposal, there is a need to study its effect, on soil properties, hence, the significance of the study. Therefore, the objective of the study is to determine the effect of different slums on selected soil physical and chemical properties.

2. Materials and Methods

2.1 Study area

This study was carried out in Abakaliki Southeastern Nigeria. Abakaliki lies between latitude 06^0 $14'$ and 06^0 $30'$N with longitude $08^0 00^1$ and 08^0 $15'$ E. The annual rainfall ranged between 1800 – 2000 mm with a mean of 1800 mm spread from April – November. There is a dry spell in August, and the rainfall resumes towards the end of the month. The mean annual temperatures during rainy and dry seasons are 27°C and 31°C, respectively. Relative humidity during rainy and seasons are from 60% and 80%, respectively (National Meteorological Institute, 2016). Geologically, the area is underlain by sedimentary rocks derived from successive marine deposits of the Cretaceous and Tertiary periods. According to the Federal Department of Agricultural Land Resources (Federal Department of Agricultural and Land Resources, 1987), Abakaliki agricultural zone lies within "asu river group" and consists of olive brown sandy shales, fine-grained sandstones, and mudstones. The soil is shallow with unconsolidated parent material (shale residuum) within 1 m depth of the soil surface. It belongs to the order ultisol and is classified as Typic Haplustult (Federal Department of Agricultural and Land Resources, 1987). The vegetation of the area includes shrubs, herbs, and grasses with some economic trees. The inhabitants are mainly farmers with few engaging in civil service and some as artisans.

2.2 Site Selection

The following locations were studied after several visitations of the site to select the study locations:

Control = Arable land
Ogbeawusa slum
Orokeonuoha slum
Mgbukobe slum
Amaikeaba slum

2.*3 Soil Sample Collection*

Four replicate undisturbed core soil samples were collected with the help of a core of 176.20 cm^3 in the study year. Similarly, four replicate soil samples were collected at the depths of 0 – 20 cm using soil auger as well. Hence, the total core and auger soil samples collected for each location per year were four replicate core and four replicate auger soil samples. These soil samples were taken to the laboratory for analyses immediately after collection.

2.4 Laboratory Analyses of Soil

Soil physical properties determined were as follows:
Soil bulk density (BD) was determined according to the method of Blake and Hartage (1986). Total porosity (TP) was determined as described by Obi (2000). Aggregate stability (AS) was determined using the wet technique as described by Kemper and Rosenau (1986).
Mean Weight Diameter (MWD) was determined using the calculation thus:

$$MWD = \sum_{I=1}^{n} XiWi$$

where;
Xi = mean diameter of each size fraction (mm)
Wi = proportion of all the sample weight
Dispersion ratio (DR) was determined using the method of Kemper and Rosenau (1986).
Soil chemical properties determined were as follows:
Soil pH was determined by using a suspension of soil and distilled water in the ratio of 2:5 – soil: water (Mclean, 1982). Organic carbon was determined by the method of Olsen and Sommers (1982). Total nitrogen was determined using a modified Kjeldahl digestion procedure (Bremmer and Mulvaey 1982). Available phosphorus was determined by Bray 11 method (Olsen and Sommers 1982).
The exchangeable base was determined using Chapman method (Chapman, 1982). The exchangeable base was determined by the titration method (Jou, 1979). The Effective cation exchange capacity was determined by the summation and calculation as by Njoku and Mbah (2012).
Base saturation was calculated as follows:

$$TEB/ECEC \times 100$$

Where:
TEB = Total exchangeable bases,
ECEC = Effective Cation Exchange Capacity.

Heavy metals (Pb, Cd, Cu, and Zn) were determined by digesting the sample in a fume cupboard and reading transmittance of light using Atomic Absorption Spectrophotometer (American Public *Health Association 1998).*

2.5 Data Analysis

The data obtained from this research was analyzed using analysis of variance (ANOVA) based on CRD and difference between treatment means were dictated using F-LSD at $P < 0.05$ according to the method described by SAS Institute Inc. (1999).

3. Results and Discussion

3.1 Effect of different Slums on Selected Soil Physical Properties

The effect of different slums on selected soil physical properties is as shown in Table 1. There was a significant ($p < 0.05$) change among the different slums studied for bulk density, total porosity, mean weight diameter, and aggregate stability. Control recorded the lowest bulk density of 1.21gcm^{-3} whereas bulk density in slums ranged between 1.28 – 1.35 gcm^{-3}. Also, the highest total porosity of 54.30% was observed in control. This observed total porosity in control was higher than total porosity in Ogbeawusa, Orokeonuoha, Mgbukobe, and Amaikeaba slums by 6, 9, 5 and 10%, respectively. The recorded lower bulk density and higher total porosity in control might be attributed to the overcrowded nature of slums that caused trampling of the soils and thereby led to soil compaction. Njoku and Mbah (2012), noted that the higher the compaction of the soil, the lower and higher the total porosity and bulk density respectively. The order of mean weight diameter increase was Orokeonuoha < Amaikeaba < Ogbeawusa < Mgbukobe < Control. Also, control recorded higher aggregate stability than aggregate stability in slums. The higher mean weight diameter and aggregate stability in control than that of slums might have been attributed to the decayed plant residues in control soils that improved the physical properties of soil and make the soil to form more stable aggregate than that of slums. Dispersion ratio shows non-significant ($p < 0.05$) change among the location studied. However, the order of dispersion ratio increase was Control < Orokeonuoha < Ogbeawusa < Mgbukobe < Amaikeaba.

Table 1: Effect of different Slums on Bulk Density (BD), Total Porosity (TP), Mean Weight Diameter (MWD), Aggregate Stability (AS) and Dispersion Ratio (DR)

Slum Location	BD (gcm^{-3})	TP (%)	MWD (%)	AS (%)	DR
Control	1.21	54.30	2.51	61.00	0.38
Ogbeawusa	1.29	51.30	2.33	53.00	0.43
Orokeonuoha	1.34	49.40	2.08	51.00	0.42
Mgbukobe	1.28	51.70	2.34	56.00	0.46
Amaikeaba	1.35	49.10	2.11	51.00	0.49
F-LSD ($P< 0.05$)	0.12	4.47	0.03	3.10	NS

3.2 Effect of different Slums on Selected Soil Chemical Properties

Table 2 shows the effect of different slums on soil pH, available phosphorus, organic carbon, total nitrogen, and C/N ratio. There was a significant ($p < 0.05$) change among the different locations studied with regard to soil pH, available phosphorus, organic carbon, total nitrogen, and C/N ratio. The order of increase of soil pH was Control < Orokeonuoha < Amaikeaba < Mgbukobe < Ogbeawusa. The higher soil pH in slums could be as a result anthropogenic deposition of wastes that are alkaline in slums. Available phosphorus was lowest (368.72 $mgkg^{-1}$) in Control while the range in slums was 369.51 – 381.50 $mgkg^{-1}$ with Amaikeaba location recording the highest value. The order of increase in organic C was Mgbukobe < Amaikeaba < Orokeonuoha < Ogbeawusa < Control. Also, Control recorded the highest total N of 3.01 g kg^{-1} whereas total N in slums ranged between 2.16 – 2.56 g kg^{-1}. The order of increase in C/N ratio was Amaikeaba < Mgbukobe < Orokeonuoha < Control < Ogbeawusa.

Table 2: Effect of different Slums on Soil pH, Available Phosphorus, Total Nitrogen, Organic Carbon and C/N Ratio

Slum Location	pH	Available P ($mgkg^{-1}$)	Organic C (gkg^{-1})	Total N (gkg^{-1})	C/N Ratio
Control	5.97	368.72	36.30	3.01	12.06
Ogbeawusa	6.83	378.43	31.41	2.16	14.54
Orokeonuoha	6.01	369.51	28.60	2.48	11.53
Mgbukobe	6.36	376.90	25.30	2.31	10.95
Amaikeaba	6.11	381.50	26.40	2.56	10.31
F-LSD ($P< 0.05$)	0.12	11.17	3.81	0.81	2.01

The effect of different slums in exchangeable bases is presented in Table 3. Table 3 also shows significant ($p < 0.05$) changes in Ca, Mg, K and Na among the different locations studied. Control recorded the lowest Ca value of 3.60 $cmol_{(+)}$ kg^{-1}. The recorded Ca value in Control was lower than Ca value in Ogbeawusa, Orokeonuoha, Mgbukobe and Amaikeaba slums by 5, 6, 10 and 6, respectively. The order of increase in Mg was Control < Ogbeawusa < Amaikeaba < Orokeonuoha < Mgbukobe. Control recorded the lowest Kvalue of 0.16 $cmol_{(+)}kg^{-1}$ while that of slums ranged between 0.24 – 0.33 with the highest value observed in Amaikeaba. The order of increase in Na was Control = Amaikeaba <Ogbeawusa < Mgbukobe < Orokeonuoha.

Table 4 presented the effect of different slums on soil total exchangeable bases, exchangeable acidity, effective cation exchange capacity, and base saturation. There was also significant ($p < 0.05$) changes among different locations studied in total exchangeable bases, exchangeable acidity, effective cation exchange capacity, and base saturation. Control recorded lowest total exchangeable bases of 6.44 $cmol_{(+)}kg^{-1}$ while total exchangeable bases in slums location ranged between 7.05 – 7.35 $cmol_{(+)}kg^{-1}$. The order of increase in exchangeable acidity was Control < Amaikeaba < Orokeonuoha < Mgbukobe < Ogbeawusa. The lowest effective cation exchange capacity of 6.72 $cmol_{(+)}kg^{-1}$ was observed in Control. This observed cation exchange capacity in Control was lower than cation exchange capacity in Ogbeawusa, Orokeonuoha, Mgbukobe and Amaikeaba slums by 15, 14, 14, and 10%, respectively. The order of base saturation increase was Ogbeawusa < Mgbukobe < Amaikeaba < Orokeonuoha < Control.

3.3 Effect of different Slums on Soil Heavy Metals Pollution

The effect of different slums on soil heavy metals is as shown in Table 5. The order of Cd increase was Control < Orokeonuoha < Mgbukobe < Ogbeawusa < Amaikeaba. Control recorded the lowest Cu content of 99.76 mg kg^{-1}. This Cu content in Control was lower than Cu content in Control in Ogbeawusa, Orokeonuoha, Mgbukobe, and Amaikeaba slums by 168, 155, 178 and 162%, respectively. The lowest Pb content of 20.43 mg kg^{-1} was observed in Control whereas Pb content in the various slums studied ranged between 301.41 – 362.41 with Amaikeaba slum recording the highest value. The order of increase in Sn content was Control < Orokeonuoha < Mgbukobe < Amaikeaba < Ogbeawusa. According to Alloyways (1996), normal ranges in soils are as follows: Cd = 0.01 – 0.08; Cu = 2 – 250; Pb = 2 – 300 and Sn = 1 – 200. Thus, apart from control, the observed heavy metal exceeded the normal ranges in the study sites.

Table 3: Effect of different Slums on Soil Exchangeable Bases ($cmol_{(+)}kg^{-1}$)

Slum Location	Ca	Mg	K	Na
Control	3.60	2.40	0.16	0.28
Ogbeawusa	3.78	2.96	0.28	0.31
Orokeonuoha	3.81	2.81	0.31	0.42
Mgbukobe	3.96	2.79	0.24	0.33
Amaikeaba	3.80	2.64	0.33	0.28
F-LSD ($P < 0.05$)	0.23	0.31	0.09	0.05

Table 4: Effect of different Slums on Soil Total Exchangeable Bases (TEB), Exchangeable Acidity (EA), Effective Cation Exchange Capacity (ECEC) and Base Saturation (BS)

Slum Location	TEB (cmol$_{(+)}$ kg^{-1})	EA (cmol$_{(+)}$ kg^{-1})	ECEC (cmol$_{(+)}$ kg^{-1})	BS (%)
Control	6.44	0.28	6.72	95.83
Ogbeawusa	7.33	0.38	7.71	95.07
Orokeonuo-ha	7.35	0.32	7.67	95.83
Mgbukobe	7.32	0.34	7.66	95.56
Amaikeaba	7.05	0.31	7.36	95.79
F-LSD ($P < 0.05$)	0.31	0.11	0.56	0.63

Table 5: Effect of different Slums on Soil Heavy Metals (mg kg^{-1})

Slum Location	Cd	Cu	Pb	Sn
Control	0.008	99.76	20.43	78.82
Ogbeawusa	0.120	267.10	301.41	236.41
Orokeonuoha	0.100	254.28	326.28	204.78
Mgbukobe	0.110	276.98	314.10	214.17
Amaikeaba	0.140	261.01	362.41	221.04
F-LSD ($P < 0.05$)	0.060	90.36	16.08	21.25

Note: According to Alloyways (1996), normal ranges in soils are as follows: Cd = 0.01 – 0.08; Cu = 2 – 250; Pb = 2 – 300 and Sn = 1 – 20

Conclusion

From the result, it can be concluded that slums degrade soils properties and make it below in soil productivity and fertility. Slums are also, sources soil pollution since all the slums studied contained heavy metals that are more than the normal range and control. The study suggests that slum soils should not be used for crop production since they are associated with heavy metal pollutions and also lack the essential nutrients required by crops.

References

Alloways, B. J. (1996). *Heavy Metals in Soils*. Halsted Press, John Wiley and Sons Inc., London, pp. 280 – 339.

American Public Health Association (1998). Standard methods for the examination of water and wastewater. Washington DC, USA.

Blake, G.R. and Hartage, K. H. (1986). Bulk Density In: Klute (ED). *Methods of Soil Analysis* part 1; American Society of Agronomy 9: 365 – 375.

Bremner J. M. and Mulvaney, C.S. (1982). Nitrogen total. In: Page, A. *et al*. (eds.) *Methods of Soil Analysis*. Part 2. ASA, Madison, Wisconsin: 595 – 624.

Chapman, H.D. (1982). Total exchangeable bases. In C.A. black (ed). *Methods of Soil Analysis* Part 11: ASA Madison, Wisconsin: 902 – 904.

Federal Department of Agriculture and Land Resources (1987). Reconnaissance soil survey of Anambra State Nigeria; *Soil report* FDALR, Kaduna.

Firdaus, G. (2012). Urbanization, emerging slums and increasing health problems: a challenge before the nation: an empirical study with reference to state of Uttar Pradesh in India. *Journal of Environmental Research and Management* 3 (9): 146 – 152.

Jalota, S. (2016). Effect of Slum redevelopment on Child Health Outcomes: Evidence from Mumbai. *Honors Thesis submitted in partial fulfillment of the requirements for Graduation with Distinction in Economics in Trinity College of Duke University.* Duke University Durham, North Carolina.

Jou, N.S.R. (1979). *Selected Methods of and Plant Analysis*, IITA Ibadan Manuel Series 1: 97 – 98.

Kemper, W.D. and Rosenau, R.C. (1986). Aggregate stability and size distribution; In: Klute, A., ed, *Methods of Soil Analysis*. Part 1,2, ed, ASA and SSSA, Madison, WI, 425 – 442.

Landon J.R. (1991). *Booker, Tropical Soil Manual. A Hand Book of Soil Survey and Agriculture Land Evaluation in the Tropics* 46: Tropics Booker late New York.

National Meteorological Institute (2016). Weather data for Abakaliki. Oshodi, Lagos, Nigeria.

Njoku, C. and Mbah, C. N. (2012). Effect of Burnt and Unburnt Rice Husk Dust on Maize Yield and Soil Physico-chemical Properties of an Ultisol in Nigeria; *Biological Agriculture & Horticulture* Vol. 28 (1), 49 – 60.

Obi, M.E. (2000). In: *Soil Physics*: *a Compendium of Lectures.* Attan to Publishers, Nsukka, Nigeria. 28 – 40.

Okafor B.N. and Onuoha D.C. (2016). The effect of slum on property values in Asaba Metropolis of Delta state. British Journal of Environmental Sciences 4 (3): 17 – 33.

Olsen, S. R. and Sommers, L. E. (1982). Phosphorous In: *Method of Soil Analysis*; Part 2. (ed) Page, A.L., Miller, R.H., Keeney, D.R., and Madison, W.I. Ame. Soc. Argon: 1572.

SAS Institute Inc. (1999). *SAS/STATS Users Guide,* Version 6, 4th ed. SAS Institute., Cary, NC.

Simon, R. F., Adegoke, A.K. and Adewale, B.A. (2013). Slum Settlements Regeneration in Lagos Mega-city: an Overview of a Waterfront Makoko Community**.** *International Journal of Education and Research* 1(3): 1– 16.