DOI: https://dx.doi.org/10.4314/gjpas.v30i4.8

GLOBAL JOURNAL OF PURE AND APPLIED SCIENCES VOL. 30, 2024: 497-507
COPYRIGHT© BACHUDO SCIENCE CO. LTD PRINTED IN NIGERIA ISSN 1118 – 0579, e-ISSN: 2992 – 4464
www.globaljournalseries.com.ng, Email: globaljournalseries@gmail.com

FACTORY-RELATED ENVIRONMENTAL POLLUTION: A STUDY OF THE IMPACT OF CEMENT DUST ON SOIL QUALITY AROUND DANGOTE CEMENT PLANT, TSE-KUTCHA, GBOKO LOCAL GOVERNMENT AREA, BENUE STATE

OKO, P. E., ASAASUEN, T., OKO, J. E., ALLY, G. A., EYO, E. E. AND UGOSOR, P. T

(Received 20 September 2024; Revision Accepted 30 October 2024)

ABSTRACT

Environmental pollution has been a close embodiment of the human society since man's first appearance on the planet earth some few hundreds of thousand years ago. This paper examines the impact of dust emission from the exploitation and processing of limestone by the Dangote Cement Factory on the soils of Tse-kucha community. Soil profile at the depth of 0 – 80 cm were dug at distances of 0.5 km (Tse-Kucha), 1.0 km (Amua) and 1.5 km (Amua) and soil samples were collected from each horizon of the soil profile. Soil samples were also collected from another profile dug at Gaando, a nearby community to Tse-kucha where there are no cement dusts in soils for comparison. The soil samples were analysed for some physical and chemical properties related to soil fertility such as pH, organic carbon, exchangeable bases; Ca, Mg, Na and K, exchangeable acidity, infiltration capacities, available phosphorous, total nitrogen, cation exchange capacity and percentage base saturation using standard analytical procedures. Additionally, structured questionnaire was designed and administered on the respondents of the study area to complement information needed on the impact of Dangote cement plant on soil quality of the study area. The results revealed a predominantly sandy-loamy composition with significant ($p < 0.05$) difference in the soil parameters tested. Furthermore, the result revealed that cement dust emissions from the factory significantly affect the yield of crops in study area. area.

KEYWORDS: Impact, Cement dust, Pollution, Soil quality, Crop yields.

INTRODUCTION

One of the major pollutants in the cement industry is dust, which is emitted from various parts of the production process such as the raw materials crusher, rotary kiln, cranes, mills, storage silos and packaging sections (Yalgado *et al*, 2023; Oko *et al*, 2023). Air-bone irrespirable particulate matter (dust) levels from less than 5 mg/m^3 to more than 40 mg/m^3 have been recorded in the air where cement factories are located (Chaurasia *et al*., 2014).

Other air pollutants such as heavy metals (HM), oxides of carbon (COx), oxides of nitrogen (NOx) and oxides of Sulphur (SOx) generated in the processing of limestone, packaging, and transportation of cement are carried by wind and settled on soil, plants and water bodies (Ugosor *et al*, 2021). Heavy metals are of environmental concern in heavily industrialized areas because of geoaccumulation, bioaccumulation, biomagnifications and biotransformations in ecosystem (Hassien 2021).

Oko, P. E., Department of Environmental Resource Management, University of Calabar, Calabar, Nigeria
Asaasuen, T., Department of Geography, College of Education, Katsina-Ala, Benue State.
Oko, J. E., Department of Educational Management, University of Calabar, Calabar, Nigeria
Ally, G. A., Department of Environmental Resource Management, University of Calabar, Calabar, Nigeria
Eyo, E. E., Department of Environmental Resource Management, University of Calabar, Calabar, Nigeria
Ugosor, P. T., Department of Chemistry, College of Education, Katsina-Ala, Benue State.

Cement factories are major sources of pollutions on crops around it as the dust deposition affect photosynthesis, stomata functioning and productivity of crops (Ugosor *et al*, 2021).

The impact of cement dust on soil fertility and plant growth has been investigated by researchers (Igomu., Odeamena & Odeh, 2023). The physicochemical analysis of the properties of soil is important to evaluate the impact of environmental pollution related to cement industries on crop yield (Mfon *et al*, 2014). It has been revealed in an earlier study that the area close to cement factory in southern Jordan has highest lead, zinc and cadmium level (Estifanos and Degafa, 2012).

It is worthy to note here that the phenomenal coming of industrialization based in factory operations into the front line of development agenda has been the most spectacular landmark of environmental pollution, (Sharma & Singh, 2020). In Africa and Nigeria in particular, industrial productivity of factory related affiliations are also highly associated with pollution which in turn go a long way in affecting environmental and human health. Upon the establishment of the Benue Cement Company/Factory in 1980 by the Government of Late Aper Aku in his radical endeavors to industrialize the state, the environs of Tse-Kucha community were heavily deforested. The location of the cement factory on the rich limestone deposit started ushering in lots of atmospheric changes including dust clouds of cement spilled into the air through pipes inside towers and right at the quarry. Within a short space of time, the locality quickly assumed an urban form while increasing dust clouds of pollutants continued to rob the air of its purity, then finally came the era of growing concerns about the dilapidating state of the environment and implications on human health and livelihood.

Furthermore, the era of industrial revolution, according to Rymarczyk (2021), introduced rapid economic changes involving radical shift from manual labour to power-driven machinery in the process of industrial productivity. Environmental pollution and land degradation took off in full force in association with increased endeavors in the area of creation of utility and subsequent distribution of same to global markets and consumption centers. Today, the phenomenon of industrial revolution which started in far-away Europe and spread to America and Africa through Germany and the far East has reached Africa, Nigeria and Benue State with spectacular landmarks right in Tse-Kutcha community of Gboko Local Government Area alongside of which is its accompanying threat to environmental and human health as well as corresponding adverse effects on agricultural productivity (Sayara 2021; Oko et al 2021).

Cement dust emission is one of the principal air pollutants near cement factories. Dust from mining and processing of limestone/cement affects directly the quality of soil, as it adds number of harmful substances to it. Although, the basic constituents of cement dust are calcium ($CaCO_3$), silicon (SiO_2), aluminium (Al_2O_3), ferric and manganese oxides (**Plate 2**), its production produces known toxic, carcinogenic and mutagenic substances, such as particulate matters, sulphur dioxide, nitrogen dioxide, volatile compounds, smoke, photochemical smog, long lived dioxins and heavy metals (Kankara *et al*, 2019a). The calcinations and burning processes of cement production produce poisonous gases that cause injuries to plants and animals (Vetiva, 2010).

Cement dust causes numerous hazards to the biotic environment, which have adverse effects and toxicological risks for vegetation, animal health and ecosystems. Plant growth parameters, yield and yield components of crops can be considerably influenced by excessive metal accumulation in soil (Kankara *et al*, 2019a). These particles deposit on the leaves of plants and also alter the chemical composition of the soil on which plants grow, thereafter affecting normal growth and productivity of crops. The particles of cement deposits are quite alkaline making soils of vicinity alkaline and changing its other properties which in turn affects vegetation growth, decreases chlorophyll content thus decreasing photosynthesis rate, decreasing respiration rate, reducing transpiration and thus growth rate. The impacts of cement pollution on morphology of Saffron plant and its productivity revealed decrease in chlorophyll content. A decrease in chlorophyll has been used as an indicator of an air pollution injury. Decrease in chlorophyll “a” chlorophyll “b” and total chlorophyll content in fresh tissues of affected leaves might be due to chloroplast damage by incorporation of cement dust into foliar tissue (Swapana., *et al*, 2024).

The effect of soil pollution on livelihoods manifests in two folds involving health and income. In this regard, Gruptal (2022) had earlier established that widespread crop failure is associated with pollution (**Plate 1**). On the other hand, it follows that agricultural communities depend substantially on incomes from agricultural products. Where the crops fail, the farmers’ livelihoods become grossly affected. Similarly, Nicholas and Ukoha (2023) in a study of atmospheric pollutants in Eastern Nigeria along Douglas Road Owerri Municipal Council and Izihe village, Uzil, Ideato North Local Government Area in the rural areas using Gasman Air Monitoring Meter Model1200-19831and other devices.

The study found that found that air quality was significantly below normal average which is prone to human health complications. It is imperative to state at this juncture that health statuses and incomes are human wealth indices. Thus, the adverse effects of soil pollution on these variables go a long way in affecting livelihood of the masses anywhere in the world.

Although, the Dangote Cement Company, Tse-Kucha, Gboko Local Government Area of Benue State recently installed a new plant that has technology for reducing emission, there are visible signs of dust in the vicinity of the factory which may impact negatively on crop production and yield. Today, after more than forty (40) years of production, the cement plant appears to have increased badland topography due to large quarries and landslides all over the place. It is against the background of the foregoing that this paper examines the impact of cement dust emission from the Dangote cement factory on the physicochemical properties of soil in relation to soil fertility and crop yield in the study area.

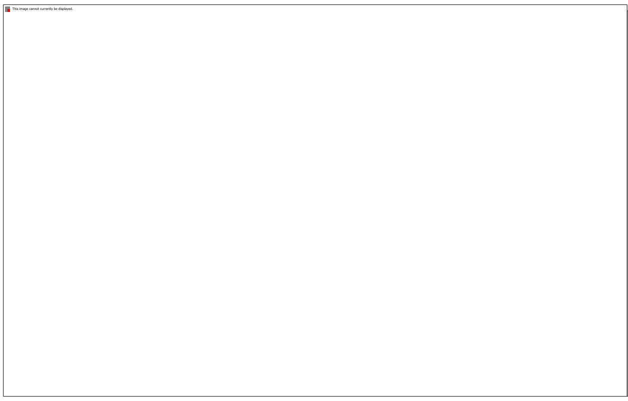

Plate 1: Inside quarry at Dangote Cement Factory Bulldozer crushes limestone into boulders (Source:Researche**s'** field survey Jan., 2024).

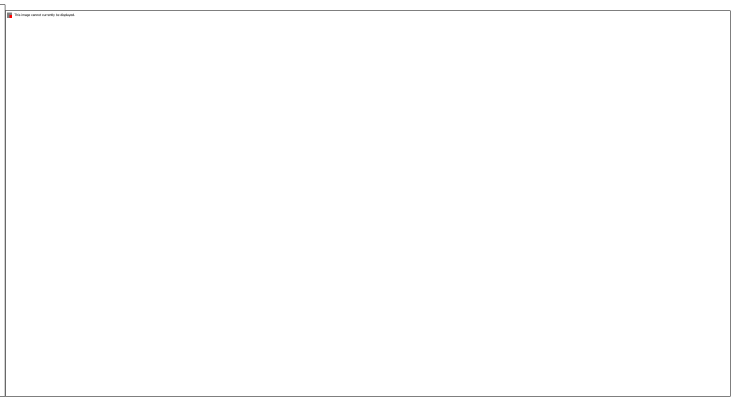

Plate 2: Heaps of limestone boulders awaiting transportation to the factory for grinding. (Source: Researche**s'** field survey Jan 2024)

STATEMENT OF THE PROBLEM

For decades, following the establishment of Benue Cement Factory at Tse-Kutcha which over time became Dangote Cement Company, air pollution from dust emissions has progressively been a major environmental issue in Tse-Kutcha community with large scale adverse effects on agricultural and human health. From the on-the-spot assessment by the researcher, it revealed the worsening state of crop yield which has translated to food insecurity and aggravated poverty levels among inhabitants of the community.

The activities of the cement factory have caused several environmental problems ranging from erosion, pollution, formation of sinkholes, vegetation loss, bio-diversity loss, heavy metal and organic contamination of the soil, groundwater and surface water (Yalgado *et al*, 2023).

It is against the background of these worst scenarios that this study evaluates the impact of dust emissions occasioned by the activities of the Dangote Cement Plant on soil fertility and crop yield in the study area.

AIM AND OBJECTIVES OF THE STUDY

This study aims to examine the impacts of dust pollution on soil quality and land degradation relative to crop yields in Tse-Kutcha community due to the operations of Dangote Cement Plant. The specific objectives include the following:

1. To examine the extent of land degradation through quarrying operations of Dangote Cement Plant.
2. To examine the impact of pollution and land degradation on arable lands.
3. To assess the impact of pollution on crops yield.

Hypotheses

The following null hypotheses are formulated for the study.

1. There is no significant link between the cement plant and soil pollution in Tse-Kutcha community.
2. Land degradation at Dangote cement factory has no significant impact on arable land in Tse-Kutcha.

3. Land degradation at Dangote cement factory has no significant impact on farmers' livelihood.

THE STUDY AREA

Tse–Kucha (Mbayion) is a community in Gboko local government area of Benue state with a geographical coordinate of 9^{o} 12` and $9^{o}$ 37` N and longitude 38^{o} 17' and 38^{o} 36` E. The study area is primarily characterized by mix of hilly terrain and low-lying plains, typically of the North central Nigeria landscape. Tse-kucha has a linear spread of approximately three (3) Kilometers along Gboko to Makurdi road with an altitude of 150 m above sea level (Ajon and Chagbe, 2018). Generally, the climate is classified as Aw (tropical rainy) by the Koppen-Geiger system. The average annual temperature in Tse–Kucha and Gboko as a whole is 26.8 ^{o}C. It has a mean annual rainfall of about 1412 mm. The driest month is January with 3 mm. Most precipitation takes place in September with an average of 264 mm (Kankara and Galadanchi, 2020). The warmest month of the year is March with an average temperature of 29.4 ^{o}C. In July, the average temperature of 25.4 ^{o}C, which is the lowest average temperature of the whole year, is recorded in July (NIMET, 2024).

The soils in Tse–Kucha are mainly sandy soils with clay sub-soils with a characteristic reddish colour. The soils are mainly ultisols (tropical ferruginous) which vary over space with respect to texture, drainage and gravel content. A typical soil profile in Tse–Kucha is highly weathered with a sandy surface layer overlying a clay mottled sub-soil (Ajon and Chagbe, 2018; Kankara and Galadanchi, 2020). Wind in the Gboko Area normally blows strongly from South-West to North-East for eight months of the year (April to November) during the rainy season, and reverses its direction in the dry season from December to March (harmattan period).

The average limestone within the area has a thickness of over 80m with a quarry-able reserve area of 1.5 Km with the mineral reserve standing at over 35.4 million metric tons (Ajon and Chagbe, 2018). The calcium carbonate ($CaCO_3$) content of the limestone within the study area according to the author is about 80% indicating that the mineral is suitable for cement production.

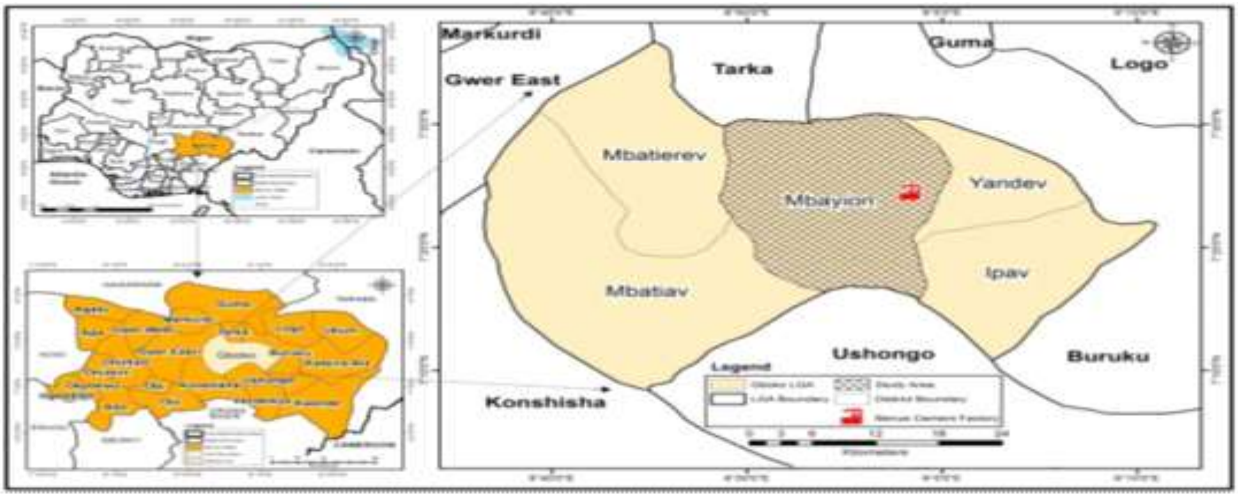

Figure 1: Gboko Local Government Area, showing Tse- Kutcha (Administrative Map of Gboko LGA, 2014).

METHODOLOGY

In this study mixed methods approach of experimental study which involved laboratory analysis of soil samples collected from the study area and administration of questionnaires on farmers were employed. The research gathered primary data generated from the questionnaire, laboratory experiments, personal observation and interactions. Composite soil samples were taken south of the factory at the depth of 0 – 80 cm at the distance of 0.5 km (Tse-Kucha), 1.0 km (Amua I) and 1.5 km (Amua II) away from the factory where there has been cement dust deposition for years. Random sampling technique was used to collect six (6) samples in each location (distance), where one representative sample was obtained for each location (distance). Samples were also collected from another profile pit dug at Gaando, a nearby community to Tse-Kucha where there are no cement dusts as soil pollutant to serve as controls. Soil auger was used for collection of the soil samples. The soil samples were collected in January, 2024. .

A total of four (4) sample points, comprising three (3) samples from the three locations and one (1) as control were air-dried, crushed and sieved using a 2mm sieve for laboratory analysis. Standard analytical methods of the Association of Analytical Chemists (AOAC, 2010) were employed in laboratory analysis of the soil samples for texture, filtration capacity, pH, organic carbon (OC), electrical conductivity (EC), Ca, Mg, Na, K, Total Nitrogen (TN), Available Phosphrus (Av. P), Exchangeable Acidity (EA). Cation exchange capability (CEC), Total Exchangeable Base (TEB), and Base Saturation (BS).

Infiltration capacity tests were carried out at four (4) locations of the study area on the field. Three (3) infiltration tests were determined in each location and one at the control site. Infiltration test was done by digging 10 cm x 10 cm x 10 cm pit at each location. Water volume of 250 cm^3 was poured into the pit and the time in second was taken and recorded for water transmission into the soil. This was repeated four times at each pit. Infiltration capacity 'K' in each location was computed using Darcy formula:

$K = Q/A \times t$

Where;

K = Infiltration capacity (cm/sec), Q = Volume quantity of water used (cm^3)
A = Cross sectional area of soil (cm^2), t = time taken for water to infiltrate (second)
The results of the infiltration capacity were compared with hydraulic conductivity classes (USDA, 2010).

The chemical properties of the soils were compared with United State Department of Agriculture, USDA soil degradation standards (USDA, 2010) and discussed in relation with fertility related parameters. The data obtained from the analysis was analyzed (descriptive statistics and inferential statistics to report the findings and to test hypothesis at 0.05 level of significance respectively) using statistical package for social science, SPSS Version 20. Results were reported as Mean ± SD. The statistical difference between more than 2 groups of data was evaluated using ANOVA with Least Significant Difference (LSD) post hoc test. Differences between means were considered significant at $p < 0.05$. The result was then compared with the USDA soil standard to ascertain the quality of the soils in relation to soil fertility in the study area. Similarly, the simple percentage was employed in analysis of survey of demographic data while Pearson Correlation was employed in testing hypotheses 3 and 4.

RESULTS AND ANALYSIS

Demographic data

Table 1: Demographic Characteristics of Respondents

S/N	Demographic & Socioeconomic Variables		Freq.	Percentage
1.	**Gender**			
	a.	Male	140	70
	b.	Female	60	30
			200	**100**
2.	**Age**			
	a.	18-30	28	14
	b.	31-40	30	15
	c.	41-50	78	39
	d.	51-60	45	22.5
	e.	60 and above	19	9.5
			200	**100**
3.	**Family Structure**			
	a.	Nuclear	85	42.5
	b.	Polygamous	60	30
	c.	Extended	55	27.5
			200	**100**
4.	**Occupation**			
	a.	Farming		
	b.	Civil Service		
	c.	Business	134	67
	d.	Others	47	23.5
			12	6
			07	3.5
			200	**100**

Source: Field survey, 2024

Table 1 shows demographic characteristics of respondents in Tse–Kutcha community. The table indicates that 70 percent of the respondents were males, while 30 percent were females. Similarly, the table shows that 14 percent and 15 percent respectively among the respondents of the sampled respondents where within the age bracket of 18 to 30 years and 31 to 40 years. In the same vein, 39 percent of the sampled population fell within the age bracket of 41 to 50 years just as 22.5 percent where within the age bracket of 51 to 60 years. Again, 9.5 percent of the sampled respondents were within the age bracket of 60 years and above.

Table 2: Mechanical composition/particle size distribution of the soil based on USDA (2010) classification

Sample location	Depth (cm)	Soil particle distribution (%)			Textural class
		Sand	Silt	Clay	
Tse-Kucha (0.5km)	0 – 80 cm	66.0	15.0	19.0	Sandy-loamy
Amua I (1.0 km)	0 – 80cm	87.0	5.0	8.0	Loamy-sandy
Amua II (1.5 km)	0 - 80cm	85.0	6.0	9.0	Loamy-sandy
Gaando (2 km)	0 – 80cm	83.0	7.0	10.0	Loamy-sandy

Source: Lab test, 2024

Table 2 shows the particle size distribution of the soil in the study area using the USDA classification guide. The result showed that the soils of the study area are of predominantly sandy-lamy texture at Tse-Kucha (0.5km), while Amua I (1km) and Amua II (1.5 km) as well as the control site, Gaando (2 km) are of loamy-sand textured. The predominantly sandy nature of soils in the four locations indicated low water holding capacity and rapid water and air transmission. The soils possess good drainage and aeration properties, implying moderate suitability for crop production but may be vulnerable to drought and cement dust pollution.

To strengthen this finding, responses from sampled respondents in respect of the magnitude of pollution were presented in Table 5.

Table 3: Extent of Pollution

Extent of pollution variables	Frequency	Percentage
Wide spread	120	60
Along factory site	14	7
Inside houses and on farmlands	66	33
Total	**200**	**100**

Source: Field survey 2024.

Table 2 shows responses of respondents on the extent of pollution. It indicates that 60 percent of the respondents pointed out that pollutants emanating from the factory site and spreads wide to affect the entire community of Tse – Kutcha and beyond. 7 percent indicated that heavy dust clouds of pollutants fill the air space along the factory site and 33 percent indicated that, both homes including the inside of house such as sitting rooms, kitchens, toilets and bedrooms are covered with pollutants emanating from the industrial activities of the Dangote Cement Plant. Consequent upon Tables 5 and 2.2 and their ananlsis, the hypothesis which states that there is no significant link between the cement plant and pollution in the community is hereby rejected in favour of the alternative hypothesis which states that there is a significant link between the cement plant and pollution in the community.

Table 4: Chemical properties of the soils

LOCATION	Horizon	Depth (cm)	Test parameter											
			pH (H_2O)	OC (%)	TN (%)	Av.P (mg/kg)	Ca (cmol/kg)	Na (cmol/kg)	K cmol/kg)	Mg cmol/kg)	EA cmol/kg	TEB cmol/kg	CEC (cmol/kg)	BS (%)
Tse-Kucha (0.5km)	A	0- 20	7.95	1.30	0.09	10.40	10.45	0.34	0.38	3.90	1.45	6.70	8.10	86.20
	B	20-40	8.50	1.46	0.08	10.44	10.49	0.40	0.40	4.33	1.31	7.69	8.99	89.00
	C	40-60	9.05	1.14	0.06	10.38	10.43	0.35	0.34	4.50	1.20	7.18	9.09	88.10
	D	60-80	9.50	1.08	0.05	10.36	10.41	0.34	0.31	4.61	1.01	7.75	9.10	86.10
Amual (1.0km)	E	0- 20	6.60	1.00	0.08	8.67	9.50	0.30	0.38	4.70	1.20	6.98	9.00	84.90
	F	20-40	7.38	1.06	0.07	9.65	9.82	0.40	0.40	5.31	0.95	7.30	8.59	85.30
	G	40-60	8.10	1.14	0.05	9.86	9.24	0.35	0.34	4.10	0.60	8.13	9.40	86.82
	H	60-90	8.52	0.72	0.04	9.94	9.34	0.34	0.31	3.95	0.32	8.07	8.94	86.32
Amua II (1.5km)	I	0- 20	5.80	1.34	0.06	10.50	8.55	0.44	0.58	3.70	1.09	6.75	8.50	87.20
	J	20-40	5.91	1.56	0.08	10.54	8.59	0.50	0.50	4.31	0.90	7.98	9.29	86.00
	K	40-60	5.95	1.34	0.06	10.69	8.54	0.55	0.49	4.10	0.50	8.00	9.43	87.15
	L	60-80	6.00	1.10	0.07	10.79	8.51	0.45	0.47	3.91	0.31	8.12	8.60	85.20
Ganndo (2km)	M	0- 20	4.20	1.40	0.08	8.80	7.	0.44	0.48	3.42	1.00	7.60	7.20	88.20
	N	20-4z	4.66	1.56	0.09	9.64	7.56	0.50	0.54	3.40	0.90	7.89	7.98	89.20
	O	40-60	4.84	1.34	0.07	9.98	7.53	0.48	0.44	3.70	0.10	7.99	7.59	88.90
	P	60-80	5.94	1.18	0.05	9.99	7.50	0.42	0.39	3.50	0.21	8.01	7.32	87.52

Key: OC = organic carbon, TN = total nitrogen, Av.P = available phosphorus, EA = exchangeable acidity**,** TEB = total exchangeable bases**,** BS = base saturation, CEC = cation exchange capacity.

Table 5: Mean ± SD of the chemical properties of the soils in the study area in comparison to USDA standard for soils

Parameter	Sample location				USDA soil standard
	Tse-Kucha (0.5 km)	Amua (1.0 km)	Amua (1.5 km)	Gaando (2 km)	
pH (H_2O)	8.75 ± 0.67	7.65 ± 0.84[a]	5.92 ± 0.09[ab]	4.91 ± 0.74[abc]	5.5 – 8.5
OC (%)	1.24 ± 0.17	0.98 ± 0.18[a]	1.34 ± 0.19[ab]	1.37 ± 0.16[ac]	1.0 - >2.0 %
TN (%)	0.07 ± 0.02	0.06 ± 0.02	0.07 ± 0.01	0.07 ± 0.02	0.2 – > 1.0 %
Av.P (mg/kg)	10.40 ± 0.03	9.53 ± 0.59[a]	10.63 ± 0.13[ab]	9.60 ± 0.56[abc]	8 – 20 mg/kg
Ca (Cmol/kg)	10.45 ± 0.03	9.48± 0.30[a]	8.55 ± 0.03[ab]	7.55 ± 0.04[abc]	2 – 20 Cmol/kg
Na (Cmol/kg)	0.36 ± 0.03	0.35 ± 0.04	0.49 ± 0.05[b]	0.46 ± 0.04[bc]	0.1 – 2 Cmol/kg
K Cmol/kg)	0.36 ± 0.04	0.36 ± 0.04	0.51 ± 0.05	0.46 ± 0.06	0.2 – 2 Cmol/kg
Mg (Cmol/kg)	4.34 ± 0.31	4.12 ± 0.62[a]	4.01 ± 0.30[ab]	3.51 ± 0.13[abc]	0.3 – 8 Cmol/kg
EA (Cmol/kg)	1.24 ± 0.19	0.77 ± 0.39[a]	0.70 ± 0.36[ab]	0.55 ± 0.50[abc]	NA
TEB (Cmol/kg)	7.33 ± 0.50	7.62 ± 0.57	7.71 ± 0.64	7.87 ± 0.19	NA
CEC (Cmol/kg)	8.82 ± 0.50	8.98 ± 0.33[a]	8.96 ± 0.47[b]	7.52 ± 0.35[abc]	6-40 Cmol/kg
BS (%)	87.35 ± 1.43	85.89 ± 0.89[a]	86.39 ± 0.97[ab]	88.46 ± 0.75[abc]	20– >80 %

Key: OC = organic carbon, TN = total nitrogen, Av.P = available phosphorus, EA = exchangeable acidity**,** TEB = total exchangeable bases**,** BS = base saturation, CEC = cation exchange capacity.

N = 6, values expressed as Mean ± SD. a = significant relative to Tse-Kucha (0.5 km) at $P < 0.05$, b = significant relative to Amua (1.0 km) at $P < 0.05$, c = significant relative to Amua (1.5 km) at $P < 0.05$.

Tables 3 represents the chemical properties of the soils in the study area and the control site respectively, while Table 4 presents the mean ± SD of the chemical properties of the soils of the study area, compared with the USDA soil quality standard. Generally, the results showed decreased concentration of the test parameters with increase in distances south of the factory. Apart from the pH (8.75) of the soils of the affected area (Tse-Kucha: 0.5 km) which was above the USDA range of 5.5 – 8.5, all the other parameters were within the acceptable limit for soil quality. The alkaline nature of the soils in the area could be attributed to the deposition of cement dust on the soil because cement dust contains lime, CaO which is known to increase soil pH. There was a significant ($P < 0.05$) difference in pH values from alkaline too acidic as the distance increased south of the factory. Thus, the hypothesis which states that pollution has no significant impact on arable lands and soil quality is hereby rejected in favour of the alternative hypothesis that there is a significant relationship.

What of comparison with the control? What are the possible causes of variations?

DISCUSSION OF FINDINGS

The result revealed values that compared favourably with USDA standard for soil quality. The high organic content could be attributed to the accumulation and deposition of plant residues on the soil surface. This finding aligns with those of Ajon and Chagbe, (2018): Kankara and Galadanchi, (2020) who studied soil pollution at the plant and found that it is linked to the operations of the factory.

Similarly, this study found that the operations of the cement plant had significant impact on the arable lands and soil quality in the locality as revealed by the results of laboratory analysis of soil sample and information obtained from the administration of the questionnaire on the resident of the study area. In the same vein, this finding aligns with those of Yalgado et al, (2023), who studied air pollution effects on arable lands in Bissa village in Burkina-Faso and reported that pollutants impede the soil’s ability to effectively absorb nutrients and eventually renders it a poor soil.

From the findings of the study the observed reduction in environmental impact mainly in the decreasing levels of parameters such as pollutants, soil quality indicators and atmospheric particulates with distance from the cement plant can be attributed to multiple factors for example dust and particulate dispersion, hence with distance, the concentration of particulates decreases due to natural dispersion mechanism such as wind, gravity and atmospheric dilution.

Secondly, the effect of soil and vegetation buffering comes into play. Soil properties and vegetation in the vicinity of plant play a role in trapping pollutions. Close to the plant, soil and plants accumulate higher amounts of dust and chemicals which decline further away as there is less airborne materials (Igomu et al'2023).

In addition are the effect of water and soil quality gradients and air quality improvement with distance which collectively mitigate pollution levels leading to lower concentration of pollutions and improved soil and air quality further from the cement plant.

The increase in soil alkalinity in the study area is likely influenced by cement production activities which can alter the chemical composition of the surrounding soil environments. It is a known fact that cement plants emit dust and particulate matter including calcium oxide (CaO) and other alkaline compounds as by product of clinker production. This is in line with the earlier work of Okonkwo et al' (2021) who found out that cement dust deposition can significantly elevate soil pH to value above the natural baseline which in turn can disrupt the local ecosystem thus limiting the growth of pH sensitive plants or crop species.

Additionally, the environmental implications of this alteration include reduced vegetation diversity, nutrient deficiencies in the soil and changes to microbial communities which can ultimately affect agricultural productivity and ecosystem health. Research around similar cement production facilities has demonstrated consistent findings of reduced vegetation cover and a shift in plant community composition due to increased soil pH (Jiang and Li, 2018).

The possible reason for the similar order of concentration of Total Nitrogen among the various sample site may be due largely to the factor of Uniform emission distribution, agricultural or natural background levels, soil type and composition including environmental and climatic conditions of the area. Hence the same order of Total Nitrogen concentration could also indicate that the cement plant emission do not significantly vary in intensity across the sites or that other environmental factors normalize Nitrogen concentration across the area.

The study finally found that pollution and land degradation significantly impacted on the livelihood of the masses.

Generally, result from the community questionnaires administered on the residence of the community collaborated the laboratory findings as residence reported decline in local vegetation, decline crop yield and soil pollution among others issues of environmental concerned. The findings also align with Gruptal, (2022) who had earlier studied pollution relative to farmers' livelihood and found out that agricultural communities who depend substantially on incomes from agricultural products are negatively affected due to crops failure.

CONCLUSION

This study examined the impact of factory related pollution focusing on cement dust emission by the Dangote Cement Plant at Tse–Kucha in Gboko Local Government Area of Benue State on soil quality and the implication for crop yields and livelihood among the inhabitants of the community. The study revealed that the pollution and land degradation in the study area is positively correlated with limestone mining and processing activities at the Dangote Cement Plant. The study also notes that arable land and soil quality have been altered in their physical and chemical compositions which in turn exert some impact on crops yield in the community and goes a long way to affecting livelihoods among the farming communities in the locality. This development, which is detrimental to environmental health and agricultural output as well as the human society calls for the attention of all development stakeholders to prevent, mitigate and adopt strategies to minimize the negative impacts and reverse the deteriorating environmental and socioeconomic statuses within the community of the cement plant.

RECOMMENDATIONS

The following measures are recommended with the view to minimizing cement dust emissions and its adverse impact on crop production and the livelihoods of the inhabitants of the study area'

- ❖ Relevant government agencies such as Federal Environmental Protection Agencies (FEPA) and the Government of Benue State should as a matter of urgency ensure that more dust controlling devices be installed in the Dangote Cement Plc that are carrying out mining and processing activities so as to balance the ecosystem and to reduce the incidence of hazard on the production of crops produced in the study area.
- ❖ Construction of earth walls around the quarry so as to lower the risks of erosion, landslides and other associated environmental problems.
- ❖ Natives whose lands and homes have degenerated beyond meaningful levels due to the activities of the cement plant should be adequately compensated through resettlement or financial compensation to enable them to relocate.

❖ Further study should be conducted to evaluate the impact of cement dust on water quality of the area.

REFERENCES

Ajon, A.T., Chagbe, K., 2018. Assessment of cement dust emissions on some physical and chemical properties of soils for agriculture in Gboko, Benue State, Nigeria. International Journal of Agriculture, Environment and Bio-research, 3(03):: 2456-864

Chaurasia, S., Kaarwariya, S., Gupta, A.D., 2014. Impact of cement industry pollution on morphological attributes of wheat, Kordinar Gujarat, India. IOSR, Journal of Environmental Science, Toxicology and Food Technology. Vol. 8 (7), Ver. II: 84 – 89.

Grupta, A.K., 2022. Effects of air Pollution on Agriculture. Atmospheric Sciences Vol.4, 28-28 DOI:10.2648/itechmag.04.2022.28

Hassien, C., 2021. The Modern Man: A Review of his Definition, and new Estimation of his Emergence Date, International Journal of Modern Anthropology. Vol. 9. No.28.

Igomu, E.A., Odeamena, S.O Odeh, I.M., 2023. Effects of Cement Dust Emitted by Dangote Factory on Some Chemical Properties of Soils of Tse-Kucha, Benue State, Nigeria. Bulgarian Journal of Soil Science, 8(2).

Jiang, W., Li, X., 2018. Impact of Cement Industry emission on Soil properties and vegetation in nearby areas. Environmental Management Review 24 (1) 112-119.

Kankara, I. A. Galadanchi, K. M., 2020. Impact of Dust Emission from Limestone Mining in Gboko, Benue State, Nigeria. International Journal of Advanced Research in Social Sciences, Environmental Studies and Technology, 5(1): 2536-6505

Mfon, G., Oluyemi, A.A., 2014. Challenges of Deforestation in Nigeria and Millennium Development Goals: International Journal of Environment and Bio-Energy.Vol.9, No.2 ISSN: 2165-8951

Oko, P. E. and Eteng, E. O., 2019. The Implication of Bush Burning on Agricultural Productivity in Obudu Local Government Area of Cross River State. Multidisciplinary Journal of Research and Development Perspective Vol. 8, No1. June. ISSN:2315-9936

Oko, P. E., Abetianbe, C. A., Asaasuen, T. and Agorye, A. O., 2021. Analysis of Socio-Economic Implication of Farmers-Herdsmen clashes on Food Security in Benue State. Journal of Agriculture, Environmental Resources and Management Vol. 5, No. 4 ISSN:2245- 1800 (P), 2245-2943 (L).

Oko, P. E., Asaasuen, T., Ako, B. T. Odey, D. U, and Robert, E. A., 2023. Population Growth and the Changing Pattern of Environmental Degradation in Gboko Local Government Area of Benue State. World Environment Journal, Vol. 3, No. 1 June. ISSN:2638-4808

Okonkwo, C. et al., 2021. Assesment of Soil alkalinity around cement production sites: A case study of Soil Chemistry and Biology. 9(2) 198-207.

Sayara, T., Hamdan, Y., Salima, R., 2021. Impact of Air Pollution from Quarrying and Stone Cutting Industries on Agricultural and Plant Bio-Diversity. Journal of Resources and Environment. Vol 6. (6): 122-126 DOI: 10.5923/jre.20160606.4

Sharma, A., Singh, B.J., 2020. Theoretical Framework and Actual Characteristics of Air Pollution Affecting Health: A Review. International Journal of Innovation Technology and Exploration Engineering. Vol.9. No.11 Sept, ISSN: 2278-3075

Swapana, S., Dixit M., Anil. K. Rakesh, S., Deepa Sharma, and Ankita, S., 2024. Concept and Assessment Methodology of Soil Quality: A Review. International Journal of Plant and Soil Science, 36, (5):164-172.

United States Department of Agriculture. Soil Survey Manual, 2010. Definitions and Abbreviations for Soil Description. West technical service centre. Portland, Oregon USA.

Ugosor, P.T., Wada, S.T, Korom, T., 2021. Environmental Pollution in the Niger-Delta Regions of Nigeria: Causes, Impact and Implications on Ecosystem. A paper presented at the 15th Bienniel Conference of the School of Arts and Social Sciences, College of Education, Katsina-Ala, Benue state.

Vetiva, R., 2010. Scheme of merger document, DCP analyst presentation: Vetiva capital management limited. initiation of coverage, Dangote Cement PLC: The Emergence of a Titan.

Yalgado, Z.,Bambara, T.L., Zongo, I., Zougmore, F., 2023. Pollution and Ecological Risk Assessment of Heavy Metals in Agricultural Soils around Bissia Village Goldmine, Burkina Faso. Journal of Environmental Pollution and Human Health 11(3) DOI: 12691/jephh-11-3-1