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CONSEQUENCES OF THE ACTIVITIES OF A NIGERIAN CEMENT INDUSTRY ON THE ENVIRONMENT

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ABSTRACT

The cement industry and its products are resources that have an impact on the landscape with dust and noise and disruption to biodiversity, sterilization of lakes and forests. There is also the reduction in populations of small invertebrates and decomposers, of agricultural yields, and extensive structural damage by corrosion from the factory. The industry may create employment and business opportunities in the area they are situated. The aim of the study is to identify the key issues of the environmental pollution and contaminants, the composition of the pollutants and contaminants and hence their effect on living caused by this resource. This study was undertaken at the Lafarge Cement Factory at Ewekoro in South West Nigeria. Samples used in this study were collected at strategic points around the factory. The results from this study showed that the water samples of Ewekoro contained Pb, Zn, and Ni with values higher than the WHO standard values and as such we suggest that the water is not portable for drinking. It is suggested that trees must be planted around the factory to reduce the pollutants. Experimental values of Fe are below the WHO standard (0.300 mg/L) in plants and water samples (0.005 mg/L and 0.030 mg/L respectively) while the values are high in the rock (2.270 mg/L) and in soils (2.720 mg/L) samples. It has been suggested that Montmorillonite ore might be present in the study areas, so we believe that. Montmorillonite could probably be a contributor to the high iron content.

KEYWORDS: *Cement, Pollutants, Contaminants*

Article History

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INTRODUCTION

The environment is the surrounding that influences life, its activities and the surrounding atmosphere for existence. It is a component in which man and other organisms live and interact, the sum total of all the surroundings of man on earth and a combination of physical, climatic, chemical, and biological conditions that may affect living organisms. Man is exposed to the social environment through literature, the arts, press radio, and television. Indeed, man is very largely a product of his social and cultural environment which he shapes and is shaped by it. Industries located in places also contribute to the shaping of the environment and one major consequence of heavy industrial presence is the release of industrial waste. Industrial waste types include substances like synthetic chemicals, acids, oils, and metals, resin pellets, organic toxins nutrients, discharges from power stations, solid wastes. The release of harmful gases such as carbon (IV) oxide and sulfur (IV) oxide from industries into the atmosphere can cause acid rain and some harmful effects of external and internal environments. The effects include sterilization of lakes and forests, reduction of the populations of small invertebrates and decomposers, reduction of agricultural yields, extensive structural damage by corrosion of marble, metal, and stonework, degradation of water supplies by leaching heavy metals from the soil [Inegbenebor, 2001, 2009].

Cement has significant positive and negative impacts at a local level. On the positive side, the cement industry may create employment and business opportunities for local people, particularly in remote locations in developing countries where there are few other opportunities for economic development. Negative impacts include disturbance to the landscape, dust and noise and disruption to biodiversity from quarrying limestone, the raw materials for cement. The objectives of this work are to identify the key issues on the environmental pollutions, the composition of the pollutants and its effect on living caused by this resource, and consider what measures should be taken to reduce the pollutant from the environment.

METHODOLOGY

Samples were collected at strategic points around Lafarge–Ewekoro Ogun State, Southwest of Nigeria. Lafarge–Ewekoro lies in 69071 (6^o54’26N) latitude, 32087 (3^o12’ 31E) longitudes and 209 (63 meter) altitude. It is 54 km to Lagos, 93 km to Ibadan, Oyo State. Its approximate population for 7 km radius from this point is 13664 people. The study area was delineated into geographical points (North, South, East, West and Central area of the factory environment, most part of the land has an aluminosilicate ore contents background variation overlain**.**

Water Samples: Three water samples were taken from the settlement areas, that is, well-water, (WW), bore-hole water (WB). These water samples were collected in plastic containers, previously cleaned with detergent and rinsed with tap water and distilled water prior to use.

Plant Leaves from the Factory Environment: Plant samples were randomly collected from the settlement site. Three samples of the leaves of their edible plants as follows: Almond Tree leaves (*Prunus amyglabus Rosaceae; PEF),* Cocoyam Tree leaves (*Colocasiae sculenta Araceae*; PEC), Banana Tree leaves (*Musa_sapientum*; PEB). Control samples of the above listed plants were collected from a non-industrialized area in Sango-Ota.

Ore Samples: These samples were taken from Lafarge–Ewekoro randomly. Samples are sedimentary carbonate in nature. Soil samples from topsoil were collected from each point at the North, South, East, West, and Central at a predetermined depth range of 0 – 10 cm of the Top soil. The color of the soil samples from the East, West, and Central was grey while soil samples from the North and South was brown.

Sample Treatment

The water parameters determined were salinity, pH, conductivity and turbidity, dissolved solids (DS), suspended solid (SS), total solids (TS). Metal analyses in water were carried out using Thermo-Electron Corporation S-Series. Atomic Absorption Spectrometer (AAS), instruments were calibrated with different standards before analyses of the samples. The pH of all the water and the soil samples were taken with Hanna instruments pH 211 microprocessor pH meters. Buffer solutions of pH 4.0 and 9.2 were used to standardize the instrument. The electrode was rinsed with distilled water before taking the pH readings. Water sample (100 mL) was measured into different beakers and the probe of the instrument was dipped and readings were taken (Hoskins, B., 1995).

Total Solids/Suspended Solids/Dissolved Solids: Evaporating dishes were washed and rinsed with distilled water, put in the oven at 60^oC for 1 h, cooled and weighed with Shimadzs AUX 320 (Unibloc) weighing balance and marked for each sample. Water sample of 100 ml was measured into each evaporating dish and put on the HHS 214 Thermostatic water bath, until the water dried off. The evaporating dishes were removed, left to cool before weighing.

Total solids, suspended solids and dissolved solids were calculated thus:

Total Solids = Dissolved Solids + Suspended Solids

Soil Analyses

Soil pH Determination: Soil sample (2 g) was weighed with Shimadzu AUX 320 (Unibloc) weighing balance into different beakers, distilled water (100 ml) was added to make a slurry of each, and the mixture was stirred thoroughly with the aid of glass rod. The pH meter was standardized with buffer solution of pH 4.0 and pH 9.2. The meter electrode was inserted into the slurry. The electrode probe was rinsed with distilled water before taking the next reading.

Soil Digestion and Analysis: Soil sample (3 g) was weighed into round bottomed flask; distilled water (3 ml) was added to it to form slurry. Six molars (6 M) HNO_3 (7.5 ml) and 6 M HCl (2.5 ml) were added. The flask was covered overnight at room temperature. The mixture was boiled gently for 2 h under reflux after which it was filtered into 100 ml standard flask and made up to mark with 2 M HNO_3. Atomic Absorption Spectroscopy (AAS) instrument was used to analyze the heavy metals in each of the samples.

Plant Leaf Analyses

Determination of Moisture Content

The dishes containing plant leaf samples were previously cleaned, labelled, oven dried and weighed (W_1). Plant leaves were then added to the dish and reweighed (W_2). The dish was placed in the oven at 105^oC. The dishes were transferred from oven to desiccator, cooled for about 24 h and weighed (W_3).

$$\%\ \text{Moisture} = \frac{\text{Loss of weight}}{\text{Weight of sample before drying}} \times \frac{100}{1}$$

$$= \frac{W_2 - W_3}{W_2 - W_1} \times \frac{100}{1}$$

$$\%\ \text{Dry matter} = \frac{W_3 - W_1}{W_2 - W_1} \times \frac{100}{1}$$

Total Ash and Percentage Organic Matter

Crucibles with lids were washed and put in a muffle furnace for 15 minutes at 35^oC. The crucibles were cooled in a desiccator for 1 h, the crucibles were weighed with Shimadzu AUX 320 (Unibloc) weighing balance and recorded (W_1). The sample, 2 g of each of was put in the crucible and weighed (W_2). The crucibles were placed in the Vaster furnace and the temperature was increased slowly from 200^oC to 450^oC (to avoid incomplete ashing, that is having black parted) until it becomes whitish. The samples were removed and put in the desiccator and allowed to cool to room temperature. The crucible and the content were reweighed (W_3).

$$\text{The Ash\%} = \frac{W_3 - W_1}{W_2 - W_1} \times \frac{100}{1}; \text{ the \% Organic matter} = 100 - \text{\% Ash}$$

Determination of % Water Insoluble Ash and % Water Soluble Ash

Distilled water (25 ml) was added to the ash sample (2 g) in the weighed crucible with lid and boiled for 5 minutes (W_1). The mixture was filtered and the residue was washed with hot water. The residue and the filter paper were placing in the crucible, oven dried and cooled in the desiccators and reweighed (W_2).

$$\text{Sample Weight} = (W_2 - W_1)\text{ g; \% Water insoluble Ash} = (W_2 - W_1)\text{ g} \times 100$$

$$\text{\% Water soluble Ash} = \text{\% Total Ash} - \text{\% water Insoluble Ash}$$

Determination of Metals in the Plant Leaf Samples

Each plant leaf sample (5 g) was dried in an oven at 105^{o}C for 1 h, weighed with Shimadzu AUX 320 (Unibloc) weighing balance into different crucibles and put in the Vaster Furnaces at 500^{o}C for 3 h. Ash sample, 2 g each was weighed into a round bottomed flask, and 20 ml of 0.1 M HNO_3 was added and heated gently on a BI Barnstead Electro thermal hot plate for 30 minutes. It was cooled and filtered into a 250 ml flask and diluted to mark with distilled water. The filtrates were analyzed for Zn, Pb, Ti, Cd, Fe, and Ni using air-acetylene flame at different absorbance.

Ore Sample Analyses

Digestion of Rock and Soil Sample: The ore was crushed with a sledge hammer. The sample, 2 g was weighed with Shimadzu AUX 320 weighing balance. Distilled water (3 ml) was added to 2 g of the soil samples followed by addition of HCl (6 M, 7.5 ml) and HNO_3 (6 M, 2.5 ml) in that order into a round bottomed flask and refluxed for 2 h. The solutions were then filtered through filtered paper and collected using100 m standard flask. The solution was allowed to cool and made up to mark with 2 M HNO_3. The concentration of each metal in the ore samples was measured using Thermo Electron Corporation S Series Atomic Absorption Spectrometer (AAS).

RESULTS AND DISCUSSION

The cement dust released as waste and pollutant in Ewekoro turns the environment grey. The road, plants, roof of buildings, etc. have the spread of cement dust. When it rains, this dust is washed down; taken into the soil and taken up by plants. The plants have stunted growth and give low yield. The physicochemical parameters of water, plants, rocks and soil samples are compiled in Tables 1 – 6.

The results of the water samples, which were found to be colorless, odorless but have taste, obtained in this investigation from locations around the factory are shown in Table 1. We can see from the table that the pH values for well water (WW) is not too different from borehole water (BW). The salinity for WW and one of the borehole water BW2 is about the same but BW1 has a salinity value very much less than values for WW and BW2. This could be the result of the difference in depth of well, which might mean better removal of salt from the water. The salinity values are well within the WHO standard for potable water. The implication of this is that the well water (WW) or bore hole water (BW) is quite suitable for consumption. The pH values were slightly alkaline (7 – 8), which are within the WHO recommended standard (6 – 8.4). There is also a wide variety in the conductivity of the water samples from BW and WW. Again, this could be the result of the difference in the depth of the wells. The well water which is taken from a shallower depth has a higher conductivity value compared to the bore hole water. There seems to be correlation between these conductivity values and the salinity values, for high conductivity value the salinity value was high. This is not actually surprising as the dissolved salts would be responsible for the conductivity. However the conductivity values are way above the recommended WHO values. Table 1 also shows that the total solids are much higher in WW than BW1 and BW 2 which have almost similar value 0.014 mg/L. These values are again way below the WHO standards total solids.

Table 1: Combined Results on the Physicochemical Parameters of Water Sample from Lafarge Ewekoro

Water Samples	pH	Salinity at 25°C mg/mL	Conductivity at 29.6°C (µs/cm)	Suspended Solids (mg/L)	Dissolved Solid (mg/L)	Total Solid (mg/L)
WW	7.43	27.0	8.10	0.025	0.063	0.088
BW1	7.61	19.2	2.37	0.013	0.001	0.014
BW2	7.31	25.8	4.01	0.014	Negligible	0.014

WW= Well Water, BW= Bore Hole Water (1 and 2 are about one kilometer apart)

The results obtained from the experiments on soil analyses are presented in Table 2. These include the physicochemical parameters of the soil, which show pH in the range 9.25 – 11.25 for all sampled sectors. The average pH for all sectors is plotted in chart shown in Figure 1. The plot indicates that all soil samples were alkaline. These average values for the sectors except for SEC (10.35) and SEE (10.48) are within the accepted WHO standard values (3.5 – 9.5) for soil samples.

Conductivity and salinity measurements are given in Table 2. Conductivity values are in the range 25.7 – 82.9 µs/cm at 29.6°C. This range is well within the WHO standard value of 25.0 µs/cm. The soil salinity values range from 19.9 mg/L – 85.0 mg/L at 25°C. This time the salinity values are well below the WHO standard for soil (2,000 mg/L at 25°C). We note, however, that there were differences in values obtained for both conductivity and salinity within the same sector. For example, we see that within the SEC, conductivity values range from 16.0 µs/cm to 30.7 µs/cm and salinity values range from 14.2 mg/L to 85.0 mg/L. It can be said that the soil is toxic to life, and not good for edible crops (Inegbenebor, 2009).

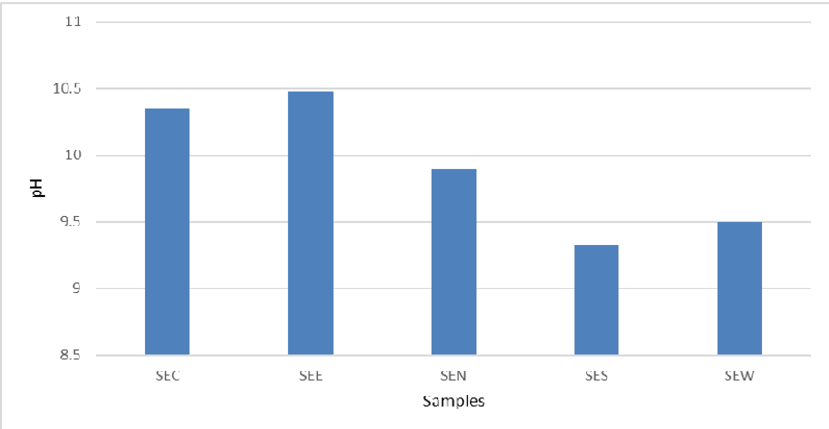

Figure 1: pH of Soil Sample Obtained from Various Sources around the Cement Factory (SEC = South East, Central, SEE = South East, East, SEN = South East, North, SES = South East, South, SEW = South East West, 1 – 6 = Number of Samples Taken from Each Location)

The AAS analytical results obtained from analyses of plant leaves, rock, water and soil samples are presented in Tables 3 – 5. In Table 6 we present a comparison of these values with the WHO standards and we see that these results indicate that the experimental values were within the WHO standard range. Experimental values of Fe are below the WHO standard (0.300 mg/L) in plants and water samples (0.005 mg/L and 0.0300 mg/L, respectively) while the values are higher in the rock (2.270 mg/L) and in soils (2.720 mg/L) samples. Experimental values of Zn in water (0.010 mg/L) and soil

(0.020 mg/L) samples are higher than the WHO standard (0.005 mg/L) while it is lower in plants (0.005 mg/L) and rock (negligible). Cadmium in plants (0.007 mg/L), rock (negligible) and soil (negligible) are within the standard limit except in water (0.030 mg/L) samples that were higher than the WHO standards (0.010 mg/L). Nickel in all the samples (plants (negligible), Water (0.030 mg/L), rock (negligible) and soil (negligible) are within the WHO standard for Ni (0.050 mg/L). Lead (Pb) was found to be higher in the water sample (0.09 mg/L) compared to the WHO standard value (0.05 mg/L) but lower in other samples (rock = Negligible), soil = (0.010 mg/L), plant (0.05 mg/L).

Table 2: Physical Parameters of Soil Analyses Collected at Strategic Points around Lafarge-Ewekoro

	Samples																	
	SEC						SEE						SEN					
	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
Conductivity at 29.6°C (μs/cm)	25.7	30.7	28.1	16.0	18.2	16.0	59.3	62.6	63.8	81.7	82.9	102.4	87.5	91.5	95.0	91.1	92.5	91.3
Salinity at 25°C (mg/L)	14.2	16.2	15.2	80.6	85.0	81.6	30.1	31.6	31.6	52.3	54.9	58.1	47.5	48.6	479.1	47.1	50.1	45.9

	Samples											
	SES						SEW					
	1	2	3	4	5	6	1	2	3	4	5	6
Conductivity at 29.6°C (μ s/cm)	44.7	44.3	42.0	34.4	43.9	52.6	44.0	42.0	42.0	41.7	42.4	42.1
Salinity at 25°C (mg/L)	24.7	23.4	23.0	19.9	24.8	29.7	22.3	22.7	22.1	22.4	22.8	22.6

(SEC = South East, Central, SEE = South East, East, SEN = South East, North, SES = South East, South, SEW = South East West, 1 – 6 = number of samples taken from each location)

The soils in these areas consist of clay materials. Montmorillonite ore could be present in the study areas. Montmorillonite, $(Ca, Na)_{0.35\text{-}0.70}(Al, Mg, Fe)_2(Si, Al)_4O_{10}(OH)_2$, (hydrous calcium-sodium aluminium-magnesium-iron silicate), is a general name for a group of clay minerals with widely varying compositions. (Inegbenebor *et al.*, 2016). Varieties include beidellite (Al-rich), nontronite, (Fe-rich), saponite (Mg-rich), hectirite (Lithium bearing), and sauconite (Zn-bearing). These clays are sensitive to changes in moisture content and present severe engineering problems when present in soil.

Awareness of the anthropogenic effect on air and water pollution from a milling industry to its environment reduces environmental problems and improves the living and health conditions of living things. Decontamination of terrestrial environments has been often costly and time-consuming, owing to the frequent occurrence of multiple pollutants, as well as the complexity of the contaminated matrices for example, soil or sediment (Selley, 2005). In plants, the alkaline in cement dust causes leaf damage and reduces yield of crops and the water is highly alkaline for washing and not portable for drinking. According to EIA (2005) the air pollutant if inhaled into the lungs may cause no detectable harm in very low concentration but due to the overlaying of limestone which has made their water alkaline and so unsuitable for drinking.

Planting trees can be a beautiful solution to the pollution problem. Trees are natural air filters, absorbing chemical impurities that create air pollution and then releasing oxygen. They trap dust, fumes and odor and help reduce the noise level in the surrounding areas (Gardiner, 2006). There is a release of air pollutant from the smoke (CO), which can be from cement plants, heavy truck, cars, generators, and the like, which can cause suffocation and death. It can as well affect the cardiovascular and nervous systems of the adults, cause headache, breathing problems. Reduction of environmental problems, improves living, health conditions of living things in an area.

Recommendation

The researchers find it needful to recommend the following: there is the need to find other environmental friendly ways of disposing of industrial waste. These methods include, deposited in landfills/incineration; release them into oceans/burying in underground caverns, and deep–well injection, where wastes are injected into permeable rocks inside deep wells. Find new uses for byproducts of industrial processes such as using waste products as fuel and recycle. The effects of the aged plants and shortage of critical inputs have manifest in a sharp decline in capacity utilization in Nigeria cement industries. The major raw materials used in the cement industry are limestone, clay and gypsum. There are other raw materials such as flash, granulated blast-furnace slag, pozzolanas, and the like that could be used as mineral additives to bring about the tremendous economic benefit to cement manufacturers. This is the current practice in the developed countries of the world, where the standard specifications for cement have been modified to make use of the different types of raw materials available locally.

Therefore, it is recommended that the equipment to reduce dust emissions during quarrying and manufacturing, and the equipment to trap and separate exhaust gases must be used. People in the environment of Lafarge should be educated on the hazards caused by the dust from this milling industry so as to stop them from eating and drinking outside their roofs and reduce the amount of the dust they will inhale.

Table 3: Results of Plant Samples Analyses Lafarge-Ewekoro (mg/L)

Plants Samples	Moisture Content	Total Ash	Water Insoluble Ash	Water Soluble Ash
PEB	4.50	4.36	2.73	1.63
PEF	2.83	6.17	4.25	1.92
PEC	4.69	7.86	5.48	2.38

PEB = *Musa sapientum;* PEC= *Colocasiae sculentum:* PEF = *Prunus amyglabus*

Table 4: Average/Mean (mg/L) of the AAS Results of Soil Samples Lafarge-Ewekoro

Samples	Fe	Zn	Cd	Ni	Pb	Ti
SEC	1.217	0.002	0.004	NEG	0.008	0.017
SEW	2.233	0.003	0.007	NEG	0.008	0.983
SEN	1.617	0.003	0.004	0.001	0.010	0.003
SES	7.33	0.003	0.007	NEG	0.011	0.030
SEE	1.183	0.130	0.003	0.001	0.008	0.006

SEC= Soil Ewekoro Central; SEW= Soil Ewekoro West; SEN= Soil Ewekoro North; SES = Soil Ewekoro South: SEE = Soil Ewekoro East; NEG. = Negligible

Table 5: Activity (mg/L) Result of Soil Samples Lafarge-Ewekoro

Samples	Fe	Zn	Cd	Ni	Pb	Ti
SEC	1.662	0.034	0.096	0.007	1.129	2.381
SEW	1.738	0.024	0.017	0.015	0.665	0.840
SEN	1.920	0.039	0.004	0.008	0.015	3.753
SES	1.464	0.027	0.018	0.015	1.408	0.033
SEE	1.857	0.157	0.004	0.013	1.120	5.715

SEC= Soil Ewekoro Central; SEW= Soil Ewekoro West; SEN= Soil Ewekoro North; SES = Soil Ewekoro South: SEE = Soil Ewekoro East;

Table 6: Comparison of the Average Values (mg/L) of the Rock, Soil, Water and Plants Samples with WHO Standards

Elements	Plants	Rock	Water	Soil	WHO
Fe	0.005	2.270	0.030	2.720	0.300
Zn	0.005	Negligible	0.010	0.020	5.000
Cd	0.007	Negligible	0.030	Negligible	0.010
Ni	Negligible	Negligible	0.030	Negligible	0.050
Pb	0.004	Negligible	0.090	0.010	0.05
Ti	3.078	0.020	3.270	0.210	-

REFERENCES

1. *E.I.A. (2005). Guidelines for Cement Manufacturing Plants, Environmental Impact Assessment (E.I.A).*
2. *Gardiner, L. (2006). Plants soak up indoor pollution. Windows to the Universe Research (UCAR). University of Michigan, USA, http://www.windows.ucar.edu/ at the University Corporation for Atmospheric.*
3. *Hoskins, B. (1995). Soil sample preparation and extraction 2nd Ed 493: 3 – 10.*
4. *Osotimehin K. O & Hassan Banjo A, Corporate Social Responsibilities and Organizational Patronage: A Case Study of the Nigerian Cement Industry, International Journal of Business and General Management (IJBGM), Volume 3, Issue 2, February-March 2014, pp. 11-22*
5. *Inegbenebor, A.I. (2009). The study of biogeoavailability of calcium in Ashaka Cement Industry environs of North Eastern zone of Nigeria, Advanced Material Research, 62-64, 380 – 384, http://www.scientific.net@2009 TransTech Publication Switzerland*
6. *Inegbenebor, A.I., (2000-2001). Metal dispersion in groundwater at drilling sites in Borno State Nigeria, Annals of Borno 17/18, 151 – 159*
7. *Inegbenebor, A.I., (2009). The study of biogeoavailability of calcium in Ashaka Cement Industr environs of north east zone of Nigeria, Advanced Materials research 62-64, 380 – 384*
8. *Inegbenebor, A. I., Inegbenebor, A. O., Mordi, R. C., Kalada, N., Falomo, A. A. and Sanyaolu, P. (2016). Determination of the chemical compositions of clay deposits from some part of Southwest Nigeria for industrial applications, IJASBT, 4, 21 – 26*
9. *Selley R. C. (2005). Environmental restoration, Encyclopaedia of Geology (2): 23*
10. *Soil and Plant Analysis Council (1999), Soil Analysis Handbook of Reference Methods. Buffer pH and Lime Requirement, Athens, Ga: 27-39, 41 – 55*
11. *Savita & Bhupinder Kaur, Study on the Impact of Cement Dust on the Health of the Cement Porters nd Supervisors Involved at Construction Sites, International Journal of Applied and Natural Sciences (IJANS), June-July 2017, pp. 57-62*
12. *W.H.O. (1986). The state of the environmental Nairobi, United National Environmental Programme, Kenya: 32 – 39.*