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Environmental Pollution of the Soil by Heavy Metals at a Dumpsite Located at Esuk Utan, Calabar, CRS, Nigeria

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Abstract The rate at which heavy metals are polluting the soil at a dumpsite and at the residential area at Esuk Utan, Calabar Municipal Government Area was investigated. This was carried out by the method of digestion using UV visible Hach 500DC spectrophotometer. Analysis of the soil samples was done for ten heavy metals. The result showed that eight of the heavy metals analyzed for had values below the World Health Organization (WHO) limit for their presence in the soil and therefore were not harmful to the environment as at the time that the samples were collected. Iron and chromium however were present at levels greater than the minimum values recommended by the WHO. These two metals were found to be present at levels that could be dangerous to human health. Some of these heavy metals can find themselves into our food chain if we eat vegetables and other crops grown in and around the dumpsite. These heavy metals have very serious health implications if allowed into our body.

Keywords: *heavy metals, spectrophotometer, WHO, health implication, environment, dumpsite*

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1. Introduction

Heavy metals are metallic elements that have relatively high density and are toxic to man and the environment even at low concentration [6]. They are found naturally in the earth. Human activities which include dumping of municipal and industrial wastes make them to be concentrated in the soil and can enter plants, animals and human tissues through diet, inhalation and manual handling. A toxic metal is any relatively dense metal or metalloid that is noted for its potential toxicity to the environment.

Municipal waste is a serious problem that causes contamination of the soil, air and water bodies. These contaminations destroy the environment and seriously endanger human health [2]. Most of the waste generated is in the form of food wastes, paper cardboards, faeces, plastics, broken bottles, batteries, textiles, bones, ceramics, expired drugs, cosmetics and other hazardous wastes [8].

In Nigeria, very large quantities of solid waste (SW) are generated in urban areas. According to Obeng and Wright [7], the average solid waste generation is 0.6Kg per person per day. Studies have also shown that cities in low income Countries like Alexandria, Cairo and Sao Paolo, the composition of the biodegradable fraction of their solid waste range from 44 percent to 87percent in weight. This portion of the solid waste is readily available for conversion into energy if the necessary technology is available [7,9]. According to Olufunke et al [9], common forms of organic waste include: domestic and market waste, fruit waste (including vegetables and fruit peelings) and charcoal ash. Organic waste also includes waste from agro industrial waste, waste generated by abattoirs, breweries processing and human faecal matter from septic tanks and treatment plants, etc.

The production and composition of municipal waste in any area is dependent to a great extend on the level of urbanization and modernization in the said area. Some general trends such as high content of organic matter (50–90 percent) provide an opportunity for exploitation through combustion processes. Anikwe and Nwobod [1] studied and recorded the percentages of organic matter in municipal solid waste in selected African cities. Their study showed that Ibadan had 56 percent organic matter in their municipal solid waste, Accra 75percent, Kigali 94 percent, Nairobi 51 percent and Abakaliki 74 percent. The volume and composition may however be subjected to large seasonal variation. According to Umwelt [10] waste composition is not a homogenous mass but a collection of different materials (organic materials, plastics, metals, textiles, etc) that can be handled in different ways to generate energy.

2. Adverse Health Effects of Heavy Metals

Some heavy metals are very useful if present in the soil at the right proportion. If these metals are however present at levels higher than the WHO standard, they become very toxic to man with very serious health implications. Although there are many heavy metals that have adverse effect on human health, only a few of them have been discussed in this work. Discussion of the adverse health effect of heavy metals is based on the heavy metals that are likely to be introduced into the ground at Esuk Utan in

Calabar, taking the kind of waste that is usually dumped at the dumpsite into consideration. It is expected that this study will enable the people living in and around the study area know the dangers they are likely to encounter if they allow these heavy metals enter into their bodies.

2.1. Cadmium

Cadmium is used for making batteries, pigments, metal coatings and plastics. It is also used for electroplating. Though cadmium is very useful it is a very toxic metal. Cadmium and compounds containing cadmium are known carcinogens. When cadmium is released into the environment it can be carried to and deposited on areas far away from the source of emission by means of long range atmospheric transport. Breathing high levels of cadmium may lead to severe damage of the lungs. Furthermore exposure of low level cadmium for a long time leads to a build up in the kidneys, lung damage and fragile bones. Exposure to high and low levels of cadmium has other health implications [4].

2.2. Chromium

Chromium is used in metal alloys for protective coatings in metals (electroplating), magnetic tapes, pigment for paints, cement, paper, rubber, etc. It is found in rocks, plants, animals and soil. Compounds containing chromium bind to the soil and are not likely to migrate to the ground water. Chromium is used in soluble form as wood preservatives. Chromium 111 is an essential nutrient. Just like cadmium, chromium is very useful but can be very dangerous to human health. Breathing high levels of chromium can cause irritation of the lining of the nose, nose ulcers, runny nose, asthma, cough and shortness of breath. Long term exposure can cause damage to the liver, kidney and skin irritation [6].

2.3. Lead

Lead is produced from activities such as burning of fossil fuel, mining and manufacturing. Lead and compounds containing lead can be found in all parts of our environment. Lead is used to produce batteries, ammunition, solder, pipes and X-ray shielding devices. The use of lead to produce many things have been drastically reduced in recent years, this is because lead can affect virtually every organ and system in the body. High level exposure to lead can severely damage the brain and kidneys, organs responsible for production of sperms in men, miscarriage in females. Virtually all organs in the human body will be affected adversely if highly exposed to lead [5].

2.4. Copper

Copper is an essential element in humans and animals. It is a naturally occurring element in all plants and animals in small amounts. Copper is released into the environment through mining, smelting and refining of copper, industrial products such as wires, pipes, metal sheets and combustion of fossil fuel, etc. Copper is a necessary component of several enzymes needed for normal metabolic functions in humans. Food sources rich in copper include shellfish, organ meats, nuts, beans and cocoa. Effects of copper deficiency can include anemia, low numbers of white blood cells, osteoporosis in infants and children, and defects in connective tissue leading to skeletal problems. Despite the health benefits of copper, excessive intake of copper can cause gastrointestinal distress, liver toxicity, destruction of red blood cells, damage to the kidneys and liver, etc [6].

2.5. Arsenic

Arsenic occurs naturally in the environment. Large quantity of arsenic is normally released through volcanic activity, erosion of rocks, forest fires and human activity. The effect of arsenic on human health can be severe or acute depending on the dose and the period of exposure. Low level exposure can cause nausea and vomiting, abnormal heart beat, damage to blood vessels, decrease production of the red and white blood cells, and abnormal sensation in the hands and feet. Ingestion of very high level can possibly cause death [4].

2.6. Mercury

Metallic mercury is used in the production of thermometers, dental filling, switches, light bulbs, batteries, etc. Mercury in soil and water is converted by microorganisms to a bio-accumulating toxin called methyl-mercury. Metallic mercury can also be used to produce chlorine gas and caustic soda. Irrespective of the good uses of mercury, it can be a major health concern if found in humans. Exposure to high level of mercury can permanently damage the brain, kidneys and developing fetus. Furthermore, the nervous system is very sensitive to all forms of mercury. Short- term exposure to high levels of metallic mercury vapours may damage the lungs, increase in blood pressure or heart beat, skin rashes and eye irritation [5].

2.7. Iron

Iron is very important to plants during the process of photosynthesis. Iron is taken up by plants through the root tips. Anything that affects the health of the tips of the roots, can affect iron uptake and result in iron deficiency. Iron deficiency may occur in rice grown on acid soils and also in cotton on heavy clay soils. If the soil has too much iron, then plants will absorb it and eventually suffer from the effect of excess iron. Excess iron builds in human organs such as the heart, liver, pancreas, joints and pituitary gland can cause organ damage and lead to heart attack, diabetes, liver cirrhosis, arthritis, depression and premature death [4].

2.8. Study Area

The study area is located at the east portion of Esuk Utan in Calabar Municipal Local Government Area, Cross River State. The area is a dumpsite besides the Export Processing Zone (EPZ) located between longitude $5^{0}2^{'}3.312^{''}$N and latitude $8^{0}21^{'}52.198^{''}$. The dump site is used for disposal of waste whose composition includes both degradable and non degradable waste from industries, commercial and residential areas. The dumpsite is surrounded by residential buildings.

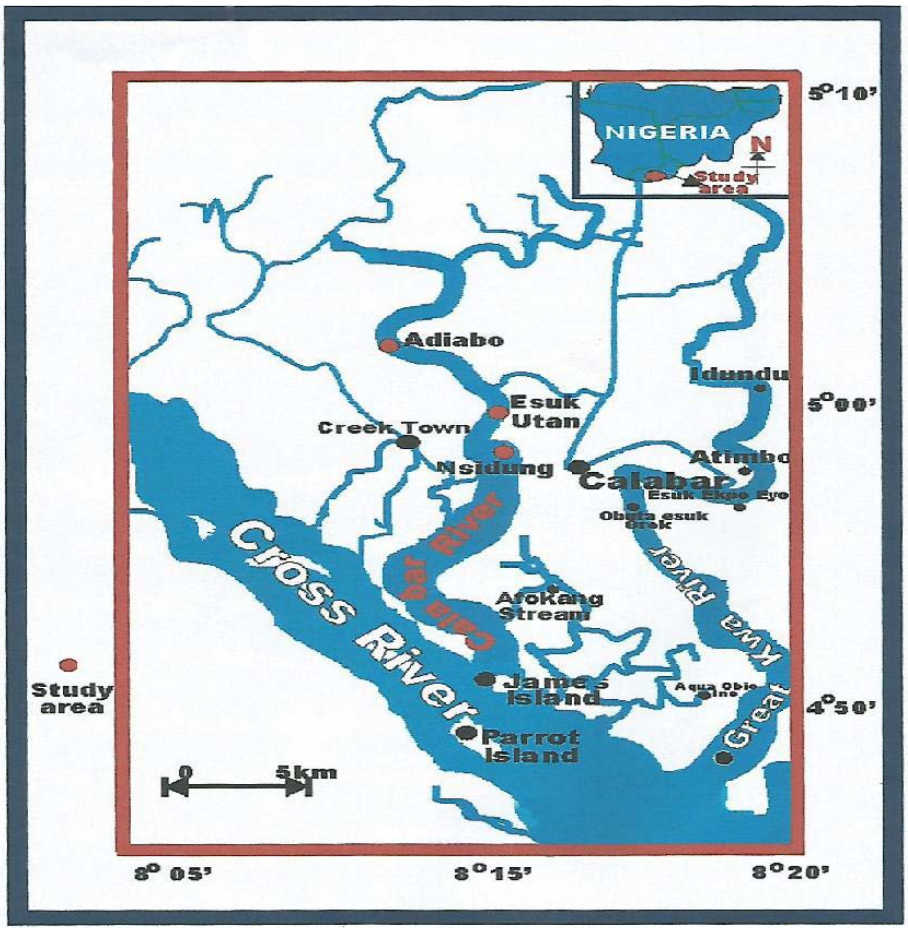

Figure 1. Map of Calabar Showing Esuk Utan [3]

2. Materials and Method

The materials used were petri dish, forceps, oven, hot plate, conical flask, beaker, test tube, foil paper, electronic weight balance and measuring cylinder. Perchloric acid, nitric acid and distilled water are the reagents used for the experiment. The soil samples were collected with the aid of sterilized plastics. The soil samples were collected 2km away from each other at the dumpsite and residential area of Esuk Utan. Using an electronic weighing balance, 5kg of the grinded soil sample was weighed and poured into a conical flask. 10mls of perchloric acid, 20mls of nitric acid and 70mls of distilled water was also added. It was swirled to mix properly and then heated on a hot plate for 30 minutes. Swirling the mixture was from time to time. The digest was then allowed to cool and filtered into a 100mls conical flask. The digest was analyzed using UV visible Hach 500DC spectrophotometer. The setting of the spectrophotometer was done according to the manufacturer's specification.

The digest was then analyzed to detect the presence of some common heavy metals taking into consideration the kind of waste that is deposited at the dumpsite. The heavy metals analyzed for included iron, chromium, copper, zinc, lead, arsenic, nickel, manganese, mercury, and cadmium. However other heavy elements may also be present at the area of study.

3. Result and Discussion

The result of the analysis of the presence of heavy metals in the area of study is as presented in Table 1.

Table 1. Amount of heavy metals in the soil at Esuk Utan at the dumpsite and residential areas

S/N	Heavy metal	Amount of heavy metals in Soil samples at the dumpsite. (mg/kg)	Amount of heavy metals in Soil samples at the residential area (mg/kg)	WHO standard (mg/kg)
1	Iron (Fe)	0.16	0.10	0.03
2	Chromium (Cr)	0.12	0.08	0.05
3	Copper (Cu)	0.09	0.08	<125
4	Zinc (Zn)	0.015	0.011	15
5	Lead (Pb)	0.008	0.004	0.01
6	Cadmium (Cd)	BDL	BDL	0.03
7	Arsenic	0.003	BDL	20.00
8	Mercury	BDL	BDL	0.89
9	Nickel	0.05	BDL	100.0
10	Manganese	0.098	0.025	680.0

N/B BDL = Below Detectable Limit.

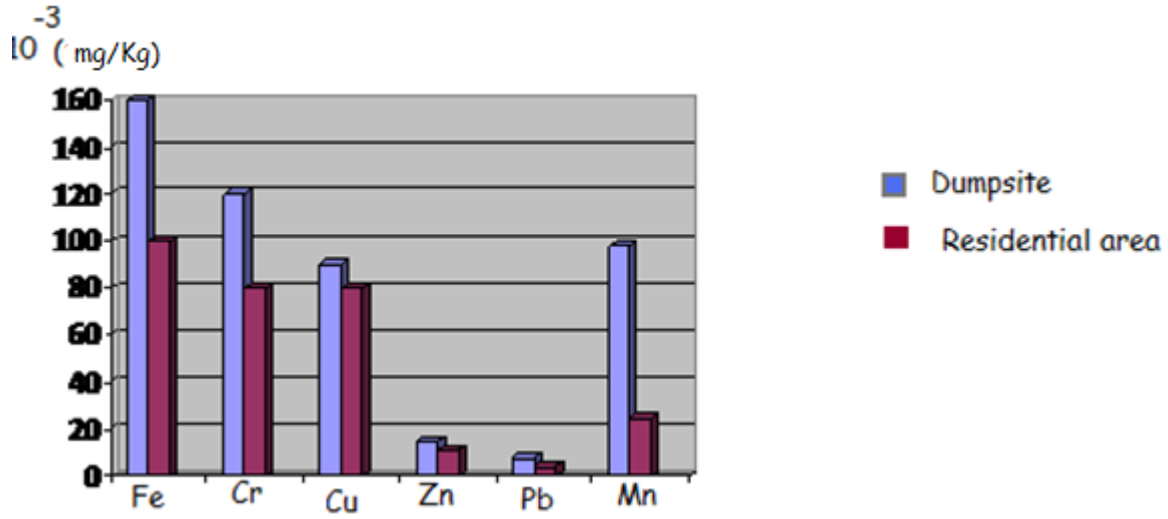

Figure 2. Bar chart showing the amount of heavy metals present in the soil in mg/Kg at the dumpsite and at the residential area of Esuk Utan

The result shows that eight of the heavy metals tested for had values below the WHO standard limit for their presence in the soil, both at the dumpsite and at the residential area. It is however clear that these metals are present at higher quantities at the dumpsite than at the residential area. What that means is that the dumpsite is gradually being polluted with the heavy metals. Although the amount present has not reached an alarming level, care must however be taken to control the kind of refuge dumped at the dumpsite. We may confidently say that the dumpsite is safe from the adverse effects of the presence of these heavy metals as at the time that the soil samples were collected. It implies that the dumpsite is a relatively new dumpsite. There is a high possibility of these heavy metals contaminating the soil beyond the WHO limit after a long period of time. This will only happen if the waste products containing these metals are continuously being dumped at the site. The Government can however stop these by not allowing waste products such as old television sets, old fridges, old batteries, expired drugs, cosmetics etc to be thrown at the dumpsite.

Furthermore, the result of the analysis of chromium and iron at the residential area and at the dumpsite showed that at both areas, the heavy metals were present at levels beyond the WHO limit. Although chromium is not likely to migrate to the water table, but taking high levels of chromium can lead to very serious health problems including damage to the liver and kidney among others. On the other hand, excess accumulation of iron can damage the internal organs of humans and lead to heart attack, diabetes, liver cirrhosis, arthritis, depression and premature death, among other problems.

4. Conclusion

The dumpsite at Esuk Utan in Calabar Municipality is a fresh dumpsite that is gradually being polluted by heavy metals. Although most of the heavy metals tested for were not yet present at levels that are considered to be dangerous to human health, but care must be taken to stop the dumping of certain waste like old electrical/electronics equipment, old batteries, expired drugs, cosmetics, etc. If this is not done, at a certain stage not too far from now, the heavy metals will be present at levels that will be dangerous to man. The Government is advised to state in clear terms, the kind of waste that is allowed to be dumped at the dumpsite, and enforce compliance. It is recommended that the amount of heavy metals present in the soil at this dumpsite be monitored. This can be done by repeating this investigation say every ten years.

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