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Impacts of Quarry Activities and Heavy Metal Contamination on Soil and Food Crops in Ebonyi State, Nigeria: A Review

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ABSTRACT

Heavy metal pollution has become a global problem due its persistence in the environment, and has many adverse effects on human health, agricultural productivity and natural ecosystems. Quarry activities are considered to be one of the most significant sources of heavy metals. High concentrations of these heavy metals and metalloids accumulate at mine sites following the extraction of these elements with economic value. This increases the natural metal content of the soil leading to heavy metal contamination of the environment. The ecological importance of heavy metals in soils is closely related to human health due to their high ecological transference potential. Available literatures have shown that abundance of heavy metals in the soils in Ebonyi state is attributed to anthropogenic activities such as mining and quarry. Most of the farmlands are located near quarry sites, thus increasing the potential of contaminants uptake by crops and the risk of human intoxication. High level of heavy metals in soil could bring about accumulation of such at high concentrations by plants thereby posing serious risks to human health through food chain. These are increasing concerns over anthropogenic activities in the Niger Delta and the potential effects on plants, animals, human health and the environment. Therefore, constant re-evaluating of heavy metals and its effects in water, soil and plants in the area is greatly required.

Keywords: Heavy metals, Contaminants, Quarry, Waste Materials, Bioaccumulation.

INTRODUCTION

Heavy metals represent one of the possible environmental hazards experienced in regions where extractive activities are carried out. These extractive activities like quarrying and mining involve blasting, crushing of rocks and use of explosives are sources of additional heavy metals in the environment. Quarry activities produce large quantities of waste materials, such as waste rock, tailings and slag (Chu *et al*., 2010). These waste materials usually contain high concentration of heavy metals, irreclaimable reagents and chemicals used in the extraction processes (Onyedikachi *et al*., 2018). This increases the natural metal content of the soil leading to heavy metal contamination of the environment. Heavy metals when released into the atmosphere often return to soil and cause water and soil contamination (Adamu *et al.*, 2015), and negatively impact the soil and plant growth. Tailings produced in acid mine and its acidification increases the dissolution of heavy metals. This is as a result of exposure of certain sulphides mostly pyrite and arsenopyrite to air and water in both active and abandoned quarry sites (Zuhairi *et al*., 2009). These toxic metals are non-degradable and persist in the ecosystem, thus posing a serious public health challenge.

The contamination of soil by heavy metals can be problematic in several levels because they are non-biodegradable and thus result in soil dysfunction. High concentration of these metals in the soil may bio-accumulate in plant tissues. Animals that graze on such contaminated plants

and drink from polluted waters, as well as marine lives that breed in heavy metal polluted waters also accumulate such metals in their tissues (Anup and Biswajit, 2015).

The water environment is increasingly exposed to metal pollution as an enormous portion of heavy metals is directed toward aquatic surroundings and accumulates in the sediments (Ahamad *et al*., 2020). The heavy metals contaminate the water by altering the environmental parameters such as pH, temperature, bioturbation, etc, causing the death of a regional aquatic population and could also accumulate in plants by means of irrigation. Continued heavy metal accumulation in sediments can also contribute to groundwater pollution (Mahipal and Rajeed 2019).

During quarrying process, dusts containing various amounts of heavy metals and toxicants are released into the air and in most cases, are deposited on the surface of the plant leaves. Plants that are very close to quarry sites tend to accumulate dusts and heavy metals, which reduces carbohydrate and chlorophyll levels, thus reducing the photosynthetic activities and causing delayed flowering (Ke, 2007). Results have shown that particulate matters coming from dusts have the potential to induce morphological changes on the plant leaves (Rai, 2016). Dust deposition on plants surfaces can induce aging of plants and reduced plant growth (Farahat *et al.*, 2016). Plants constitute one pathway for toxic metal mobilization into human system. Prolonged exposure and increased accumulation of such heavy metals may have detrimental effects on human life and aquatic biota in terms of poor health.

Quarrying has the potential of destroying habitats and the species they support (Samant, 2014). Even if the habitats are not directly removed by excavation, they can be indirectly affected and damaged by environmental impacts of these activities. Therefore, the objective of this review is to highlight the impacts of mining and quarrying activities on soil and food crops in Ebonyi State, Nigeria.

Study Area: Ebonyi State

Ebonyi is called "the salt of the nation" for its huge salt deposit at the towns of Okposi, Uburu and Oshiri, zinc and lead at Enyigba, as well as kaolin and lime stones at Ishiagu, Afikpo and Nkalagu. The State is blessed with other solid mineral resources like granite, barytes, kaolin, marble-stone, Gypsum, False Gold, Igneous rock, Aluminium, etc. The agricultural lands as well as the mineral resources of Ebonyi State offer enormous potentials for profitable investment by local and foreign interests. The people of Ebonyi State are predominantly farmers and traders and about eighty five percent (85%) of the population earn their living from one form of agricultural activity or another. Ebonyi State's agricultural productivity is one of the highest in Nigeria and the popular Abakaliki brand of rice is cultivated throughout the state.

Quarrying Activities in Ebonyi State

Ebonyi State, lies within the Southern Benue Trough with a sedimentary succession. The state is associated with the occurrence of volcanic igneous intrusions with sedimentary rocks. Due to its geologic formation, the state is blessed with abundant solid minerals like granite, limestone, marble, slate, etc (Edet *et al.,* 2011). The abundance of these natural resources in the state has triggered the excavation and exploitation of these resources for economic benefits and this has led to increased quarrying activities, quarry sites and industries. Ebonyi State has a vibrant quarrying industry that dates back to the 1950s (Chima *et al*., 2010). Over time, the state has experienced a considerable increase in quarrying operations with about 400 private operators producing over 100,000 metric tons of solid materials per annum (NEITI, 2013). The unsustainable practices of many of these companies are inimical to conservation of vegetation cover and land use systems of the host communities. Ebonyi state is characterized by abandoned mining ditches, open pits, heaps of overburden and tailings. Plates1-3 show some of the quarrying sites in the state at varying stages.

Plate 1: Active Quarry site in Nkalagu, Ebonyi State

Plate 2: Heap of overburden at quarry site in Amasiri Community

Plate 3: Abandoned site at Izzi

The ditches become areas of wasteland and sources of acid and metal-rich runoff from land-sited tailings, piles or waste-rock heaps which subsequently lead to soil, surface water and groundwater pollution.

Quarrying activities and the release of heavy metals to the environment

The discoveries and exploitation of mineral resources in Nigeria have led to the economic development of most sectors but the people's livelihood and natural environments have been negatively impacted. Extractive activities like quarrying generate tailings, overburden, gangues etc and are the hazardous sources of toxic elements which have caused noticeable significant environmental problems among local communities. Heavy metals present in tailings can also be released to surrounding soils, streams, and groundwater through erosion, weathering, and leaching over a long duration even after the cessation of mining activities.

Also, the fine-grained particles of mine tailings or the ores are blown or diffused into adjacent areas while acid-mine drainage contamination has led to the contamination of nearby terrestrial and aquatic habitats (Oyebamiji *et al*., 2018a). The environmental impacts of quarrying activities have similar effects worldwide and these effects are determined by the chemical attributes of the parent rock, the method of extraction and the environmental conditions (Khan *et al*., 2016). The mobility and bioavailability of these elevated heavy metals in the environment mostly depend on some physical and chemical characteristics of the surrounding environment such as pH, soil textural characteristics, organic matter content, speciation or chemical form, and electrical conductivity (Adewuyi and Osobamiro, 2016).

Soil is not only a geochemical habitat for the contaminants, but also serves as a natural buffer for transportation of heavy metal in the air, water, and biomass (Oyebamiji *et al.,* 2018b). These heavy metals can be easily inhaled into human bodies from suspended dust or by uptake in plants when consumed (Benson, *et al.,* 2017). Due to the high elevated values of heavy metals in soils, they have posed a huge adverse effect on human health and aquatic environment.

Particulate Matter is a portion of air pollution that is made up of particularly of small particles and liquid droplets containing acids, organic chemicals, metals, and soil or dust particles. It is categorized by size and Researchers define a diameter between 2.5 and 10 μm ($PM_{2.5–10}$) as "coarse," less than 2.5 μm as "fine," and less than 0.1 μm as "ultrafine" particles (Anderson *et al*.,2012).

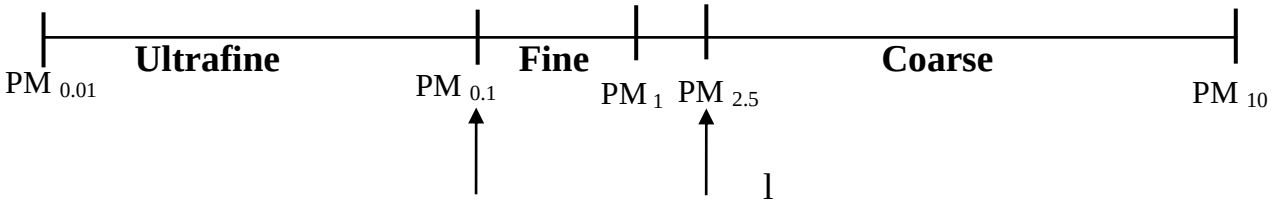

Fig.1: Aerodynamic diameter of particulate matter
Source: Anderson *et al.,* 2012

Small particles of concern include "inhalable coarse particles" with a diameter of 2.5 to 10 μm and "fine particles" smaller than 2.5 μm in diameter. The World Health Organization estimates that $PM_{2.5}$ concentration contributes to approximately 800,000 premature deaths per year, ranking it the 13th leading cause of mortality worldwide (WHO report 2002). Particulate matter (PM) is the primary source of air pollution in quarry sites mainly from rock blasting and crushing activities. These particulates are dispersed by their suspension and entrainment in airflow and its dispersal is affected by the particle size, shape and density, as well as wind speed and other climatic effects. These particulates are considered to be more dangerous, because they are occasionally inhaled deeply into the tracts, hence settling in areas where the body's natural cleaning mechanisms cannot remove them (Bakamwesiga *et al*., 2021). It is associated with a wide range of health disorder as it affects respiratory and cardiovascular systems, causes asthma, silicosis, thickening of lungs walls, development of scar tissue and later mortality.

The water environment is increasingly exposed to metal pollution, as most pollutants are adsorbed by the suspended particles in water. On the other hand, Open pits within quarry sites act as water collection points/pools during heavy rains and quarry operators usually empty these pits by pumping water into an open environment (Ozean et al 2012). This wastewater usually finds its way into community water sources especially rivers, streams and shallow wells thereby making the water unfit for consumption. This is a challenge to the surrounding communities and it creates unending conflicts between the community and quarry operators.

Impacts of Quarry Activities in Ebonyi State

The extractive industries have increased enormously in the last sixty (60) years in response to increasing demands for more energy and primary commodities**.** This has resulted in a serious environmental pollution in the state due to large quantities of waste generated and scattered all over the place without proper treatment.

These waste materials are mostly dumped on slopes or stacked on farmlands near villages. According to Osuocha *et al.* (2015), the dumps contain harmful minerals and chemicals that contaminate the soil, plant and water, and impair

air quality. When exposed to weathering, leaching and decomposition, water containing heavy-metal slowly drains into the soil. The vicinity of most mining sites in Ebonyi State is often used as arable farmlands for cultivating edible food and medicinal plants. In some communities, a large proportion of cultivable land has been contaminated with heavy metals as reported by some researchers. For example, the study on Lead-Zinc mining site in Ezza south of the state, revealed that many heavy metals (Pb, Zn, Fe, Cu, Ni, Mn, Cr) are present in the soil samples collected from different farmlands (Aloh *et al*., 2016). Also, a study near operational and abandoned mines in Enyigba, Ameri and Ishiagu in Ebonyi State identified the following heavy metals Pb, Zn, Ni, Co, Mn and Ag in the soil samples above the normal soil composition (Nnabo, 2015). Another study in Ishiagu revealed that vegetables grown on soils into which mining effluent was discharged accumulated high levels of trace metals compared to those from the control site (Osuocha *et al.,*2016a).This indicates potential health risks associated with prolonged consumption of edible vegetables grown in these soils. However, after 8-10 years of mining activities in Ishiagu Community, an estimated 6-7 excavates were abandoned and 3-4 mining pits with average depth of 40m and covering an area of between 900-1200m^2 each are existing in the area without any sign of being remedied (Essaghah *et al.,* 2013). These pits contain large amounts of tailings and are therefore unable to support any form of living organisms and have resulted to erosion of the soil and continued contamination of the surrounding from littered waste, and release of leachates.

In terrestrial ecosystems, soil is an important component which supports plant growth and biogeochemical cycling of nutrients that are vital to the ecosystem. The presence of heavy metals in the soil interacts with the soil system thereby changing the physical and chemical properties. Also, the long-term input of heavy metals could result in decreased buffering capacity of soil, threatening the ecological environment. High level of heavy metals in soil could indicate similar concentration in plants by accumulation at high concentration causing serious risk to human health when consumed. Accumulation of heavy metals in crops grown on metal-polluted soil may easily cause damage to human health through food chain which results in number of diseases.

The uptake of heavy metals by plants through absorption and subsequent accumulation along the food chain is a potential threat to animal and human health. A study in Ishiagu indicated that well water samples near Ishiagu quarry mining sites are contaminated with heavy metals (Osuocha *et al.,* 2016b). This suggested negative impact on nutritional composition of vegetables grown on soils receiving irrigated waste water particularly during the dry season. Also, the result of a study on some food crops and vegetables collected from a farmland near Enyigba mining site showed that these food crops bioaccumulated to toxic levels these metals above the permissible values set by world health organization (Orji *et al*., 2021). This can significantly contribute in its transfer into the human body through ingestion via the hand–mouth pathway, inhalation and dermal contact.

According to USEPA (2008), quarry activities have significantly contributed to particulate matters in the environment among all pollutants. It has been associated with inhalable dust which is produced during processing, grading and during the transit by heavy-duty vehicles. There are occupational hazards which significantly predispose the workers and residents of the surrounding community to high vulnerability to air pollution and other health problems. The study on dust related health problems on workers from selected local government areas in Ebonyi state shows that the dust related health problems are higher in quarry workers when compared to practitioners of other occupations like famers and Traders (Nwazunku *et al.,* 2020). The observed health related problems include sneezing, short breath, coughing, sore throat, asthma, etc. The particular health hazard in quarrying is the inhalation of dust containing

silica which can lead to silicosis, lung cancer, pulmonary tuberculosis and airway diseases (Isara *et al*., 2016; Gholami *et al.,* 2020). A study conducted on some haematological parameters among quarry workers at Umuoghara shows significant haematological changes which are as a result of occupational exposure (Chukwurah *et al*., 2020).According to (Guguloth *et al.,* 2012), this is an indication of effect of quarry dust on pathophysiology of blood and reticuloendothelia system of factory workers and in general human health.

Children, apart from engaging in processing the mineral ore commodities, also play on the mine tailings and dumps. During these activities, they inhale mine dusts from the atmosphere or ingest it through hand to mouth contact, thereby exposing them to hazardous substances which portend grave danger to their health. This also increases the release of heavy metals in the surrounding environment. These activities, coupled with prolonged human exposure and ingestion of the contaminated edible food plants, have effects on the people living within vicinity of the site.

The Loss of natural vegetation as a result of extractive activities like quarry poses risk to the surrounding area as it increases soil erosion, local flooding and water pollution and siltation. Mining and quarry have long been in existence; some of the pits have been abandoned and over the years have developed into gully sites. Several active major gully sites are spatially distributed in the state and have caused massive damage to land and vegetation cover (Akanwa *et al*., 2016). The absence of these vegetation cover facilitates lateral wind erosion of metal contaminated particles and the volume of water percolating through the soil could eventually contaminate the underlying ground water.

Water resources are under severe strain in developing countries as industrial and mining pollutants are dumped into water bodies with little or no concern for the bodies' ability to absorb them. The activities of quarrying in Ebonyi State have impacted greatly on water bodies, the explosives used during rock blasting leads to release of particulate matters which causes water pollution (Gauch, 2001). A study on water quality from some selected locations in Ebonyi shows that Pb, Cd, Fe and Zn are higher than the standard limits (Okafor and Njoku, 2021). According to the observed results, quarry activities have impacted the water and aquatic organisms residing in the waterbodies in the areas. Water available within the Enyigba mine vicinity has been contaminated by potentially toxic elements from tailings emanating from mining activities through wind and water within the vicinity of the mine area. The study in Enyigba has also shown that open cast mining evidently impacted on the water usage, thus leading to heavy metal contamination of surface water bodies such as rivers, streams, and ponds (Okolo *et al.,* 2018).

Effect of quarry and heavy metal contamination

The various impacts of dust and waste containing heavy metals generated from quarry operations are on the air, water, soil, earth surface, flora and fauna, and human beings. Generally, humans are exposed to these metals by ingestion through drinking of contaminated water or inhalation of dust and fumes bearing heavy metals.

Effect on Soil health

Quarry activities have contributed immensely to Soil heavy metal contamination throughout the industrialized world. These activities contaminate the soil leading to high presence of metals. This has not only resulted to adverse effects on plant quality and yield but has also caused changes in the size, composition and activity of the soil microbial community. Heavy metals indirectly affect soil enzymatic activities by changing the microbial community which synthesizes enzymes. Soil enzyme activity is considered to be one of the biochemical indicators of soil health and the effect of heavy metals on soil enzyme activity vary with the types and concentrations of metals, the sensitivity of the enzymes and soil properties

(Caldwell, 2005). For example, a study showed inhibiting urease activity in the decreasing order of Cr > Cd > Zn >Mn>Pb (Shen *et al.,* 2005). The result revealed that soluble forms of heavy metals (Ag, Cu, Hg and Zn) were considered to be more toxic to enzyme activities (urease, dehydrogenase and acid phosphatase) due to their high bioavailability. Cadmium is more toxic to enzymes than Pb because of its greater mobility and lower affinity for soil colloids whereas Cu inhibits β- glucosidase activity more than cellulose activity (Chaperon and Sauve, 2007). The resultant effects of the above toxicity include destroying the spatial structure of the active groups of the enzyme; the growth and reproduction of microorganisms are inhibited, thus reducing the synthesis and metabolism of the microbial enzyme (Chu, 2018). There is a very close relationship between soil enzymes and soil microbes, and some microorganisms and enzymes secreted by microorganisms participate in the circulation of soil ecosystems and energy together. These toxic effects towards soil biota affect key microbial processes and decrease the number and activity of soil microorganisms.

Diversity and activity of soil microbes play important roles in soil quality such as recycling of plant nutrients, maintenance of soil structure, detoxification of noxious chemicals, the control of plant pests and plant growth communities. E.g. Chromium is usually present in soils as Cr (III) and Cr (VI), which are characterized by distinct chemical properties and toxicities. The Cr (VI) is a strong oxidizing agent and is highly toxic, whereas Cr (III) is a micronutrient and a non-hazardous species 10 to 100 times less toxic than Cr (VI) (Garnier *et al.,* 2006). According to Shun-hong *et al.* (2009), Cr (VI) has caused shifts in the composition of soil microbial populations and caused detrimental effects on microbial cell metabolism at high concentrations. The heavy metal toxic effects on soil microorganism result in the change of the diversity, population size, and overall activity of the soil microbial communities and influenced the metabolism of soil microbes in all cases.

Effects of heavy metals on plants

Different stages of quarry mining processes cause permeation of metals into environmental media like soil, water, and plant species around the operation areas. Heavy metals at excessive levels are detrimental to plant growth and are potential threats to animal and human health. For example, Mn, Pb, Cd, Cr and Co are known to reduce growth of maize (*Zea mays* L.) and the toxic effects increased with increasing metal concentrations (Ghani, 2010).

Heavy metals at elevated concentrations can cause oxidative stress in plants, damage cell structure by substituting the deficient element with the toxic heavy metals, and hamper photosynthetic reactions in plant cells. For example the growth of pea plants (*Pisumsativum*, cv. Citrine) was reduced in the presence of excessive Zn while the uptake of Zn by the roots and its transport to the shoot increased as the Zn concentration in the nutrient solution increased (Doncheva *et al*., 2001).

Heavy metals affect seed germination in different ways and thus potentially reduce crop production. A study shows that some enzyme activity (amylase, protease and ribonuclease) was retarded due to Ni toxicity and thus affected seed germination and crop growth (Ahmad and Ashraf, 2011). Other negative effects of Ni in seed germination and plant growth include; the digestion and mobilization of proteins and carbohydrate, reduced plant height, root length, chlorophyll content, carbonic anhydrase enzyme activity (Siddiqui *et al*., 2011). High content of Pb in soils may decrease soil productivity, and a very low Pb concentration may inhibit some vital plant processes, such as photosynthesis, mitosis and water absorption with toxic symptoms of dark green leaves, wilting of older leaves, stunted foliage and brown short roots (Bhattacharyya *et al.,* 2008). The potential toxic and phytotoxicity effects include chlorosis, weak plant growth, delay seed germination, yield depression, reduced nutrient uptake, disorders in plant metabolism, and reduced ability to fix molecular nitrogen in leguminous plants (Guala *et al.,* 2010).

Heavy metal accumulation in plants depends on plant species and the efficiency of different plants in absorbing metals is evaluated by either plant uptake or soil to plant transfer factors of the metals. Several studies have found that heavy metals are easily accumulated in various edible vegetables and fruits through contaminated soil (Zhou *et al.,* 2016). According to Wang *et al.,* (2006a), Lead (Pb) and Cadmium (Cd) accumulated in basil, ginger, turmeric, lemon grass, parsley, onion and coriander glory. The results of the study in Enyigba, Ebonyi State revealed that bitter leaf and garden egg leaf, waterleaf accumulated As, Cr and Pb above World Health Organization (WHO) acceptable limits (Oti and Nwabue, 2013). These three vegetables are in high demand in Abakaliki and other areas within the locality because they are part of daily staple food.

Effect on human

These rocks when crushed produce dust exposing the people to risks of inhaling the heavy metals, which are known carcinogens. Humans are exposed to these metals by ingestion, by drinking contaminated water or inhalation of dust and fumes bearing heavy metals. Inhalation of the dust can cause severe health problems including respiratory and pulmonary problems, while dust deposition causes skin and eye problems.

The plant uptake of heavy metals from soils at high concentrations may result in a great health risk taking into consideration food-chain implications. Also the chronic low-level intake of soil through ingestion or inhalation has a serious negative effect on human health. Heavy metals become toxic because they are not metabolized by the body and therefore accumulate in the soft tissues. Chronic level ingestion of toxic metals has undesirable impacts on humans and the associated harmful impacts become perceptible only after several years of exposure.

When these heavy metals are transferred into food chains, they accumulate in vital organs, such as the liver, kidney, bones, and this poses a threat to human health which results to several health disorders. For example, chronic exposure to Cd is associated with harmful effects such as lung cancer, prostatic proliferative lesions, bone fractures, kidney dysfunction, and hypertension (Satarug *et al.,* 2003). The chronic effects of Arsenic (As) include bladder cancer, kidney cancer, skin cancer, lung cancer, and liver cancer (Jolly *et al.,* 2013). Exposure to lead (Pb) may cause plumbism, anaemia, nephropathy, gastrointestinal colic, and central nervous system symptoms (Li *et al.,* 2014). Heavy metal contaminated vegetables can cause gastrointestinal cancer and heart disease, damage the memory and intellectual abilities of human beings, disrupt numerous biochemical processes, and lead to cardiovascular, nervous, kidney, and bone diseases (Zafarzadeh *et al.,* 2018).

Zinc (Zn) is known to be relatively non-toxic, especially if taken orally. However, excess amount can cause system dysfunctions which results in impairment of growth and reproduction. The clinical signs of zinc toxicities include vomiting, diarrhea, bloody urine, icterus (yellow mucus membrane), liver failure, kidney failure and anaemia (Singh *et al*., 2010).

Copper (Cu) is an essential element in mammalian nutrition. Conversely, exposure to excessive levels of Cu can result in a number of adverse health effects such as severe mucosal irritation and corrosion, widespread capillary damage, hepatic and renal damage and central nervous system irritation followed by depression (Turkdogan *et al*., 2003). Severe gastrointestinal irritation and possible necrotic changes in the liver and kidney can also occur.

Nickel exposure and inhalation have resulted to several acute toxic effects like nausea, vomiting, vertigo, irritation, all types of respiratory disorders (asthma, bronchitis), damage to the lungs, nervous system, and mucous membranes (Das *et al*., 2008). It has been reported that nickel contact caused allergic dermatitis and immunologic urticarial, hence, nickel can be marked as both immune sensitive as well as an

allergen (Das and Buchner 2007; Das *et al.*, 2018).

Chromium (Cr) is the 10th abundant element in the earth's mantle and persists in the environment as either Cr (III) or Cr (VI). Cr (VI) is toxic to plants and animals and its toxicity is derived from its ability to diffuse through cell membranes and oxidize biological molecules (Jeyasingh and Philip, 2005). Chromium enters the body through the lungs, gastrointestinal tract and to a lesser extent through skin. Inhalation is the most important route for occupational exposure, whereas non-occupational exposure occurs through ingestion of chromium-containing food and water. Regardless of route of exposure, Cr(III) is poorly absorbed whereas Cr(VI) is more readily absorbed. Generally, chromium is very toxic by dermal and inhalation routes and causes lung cancer, nasal irritation, nasal ulcer, hypersensitivity reactions and contact dermatitis.

Effect on Land use and Vegetation cover

Mining and quarry are destructive enterprises and involve complete destruction of the habitat of an area where they are carried out. The destruction and fragmentation of habitat is the greatest threat to biodiversity and the primary cause of species extinction. A study on vegetation and landform in Niger State shows that quarry operations have destroyed the landscapes, caused loss of vegetation and species extinction (Ako *et al.*, 2014). One of the biggest negative impacts of quarrying on the environment is the damage to biodiversity hence destroying the habitats and the species they support. Even if the habitats are not directly removed by excavation, they can be indirectly affected and damaged by environmental impacts such as changes to ground or surface water that causes some habitats to dry out or others to become flooded. Even noise pollution can have a significant impact on some species and affect their successful reproduction. A study in Odeda L.G.A, Ogun State also revealed that quarrying has led to destruction of the landscape, loss in vegetation cover, alteration of water courses, occurrences of landslides and soil erosion along quarrying sites (Adedeji *et al.*, 2020).

Quarrying activities affect vegetation cover by hindering it from performing its biological roles among which is the photosynthetic processes by which environmental pollutant, carbon dioxide is converted to life sustaining oxygen. In active sites, removal of the top soils, trees and vegetation with heavy machines deprives the land of its nutrients, renders the soil infertile for agricultural purposes and causes soil compaction. This reduces infiltration, increases surface runoff and erosion. A study on a site in Ishiagu area of Ebonyi State showed that the land had been covered by rocks and other debris from quarrying activities (Akanwa *et al*., 2017). This has not only impeded plant growth on the land but has also rendered the surface rugged, making it impossible for productive farming.

In most developing countries, quarry is not well managed for environmental sustainability. The methods used are very poor and there is no order in resource exploitation. Most of the quarries collapse and there is no measures taken to rehabilitate them, thereby leaving them open. During Field observations such pits were observed at Nkalagu, Amasiri, Akpoha with depths ranging from about 50-85m deep. They are either covered with rocks or water or are converted into waste pits where effluent and other toxic materials are deposited. These deep pits and ponds may contain various pollutants and heavy metals, some of which are toxic in nature and affect the environment when their concentration exceeds the permissible levels.

Effect on water resources and quality

Mining and quarrying are sources of water contamination and most pollutants are adsorbed by the suspended particles in water (Yi *et al.*, 2020). Furthermore, the quarry operations surrounding the natural water sources like rivers, streams had led to the contamination of these natural water sources with mud and could render them inaccessible, especially during the rainy

season. Uncontrolled dust from drilling and crushing activities normally finds its way into community water sources, especially rivers and shallow wells making the waters unsuitable for consumption. The study on water sources around quarry community in Ishiagu shows that the metals (Al, Cd, Fe, Zn, Pb, Ca, Cu, and Mn) occurred above WHO permissible limits for drinking water (Akubugwo *et al*., 2012). Therefore, the water sources are contaminated and unfit for human consumption. Also, a study on water sources around a quarry site in cross Rivers revealed that mean concentration of some heavy metals Ba,Cu,Mn,Pb and Zn are above the recommended standard for drinking water quality. This result showed that the water is not suitable for human consumption.

Effect on Air Quality

Quarrying activities operate in complex and intricate ways which require drilling, blasting, and the use of machinery to grade rock materials thereby generating airborne particulates such as dust, sulphur dioxide (SO_2), Nitrogen dioxide(NO_2), Carbon monoxide(CO), and black smoke (Ayodele *et al.,* 2014). A study in Abuja showed that air pollutants such as particulate matter (fine inhalable particles $PM_{2.5}$ and inhalable particles PM_{10}) and greenhouse gases like CO, CO_2, NO_2 and SO_2 are detected within the quarry site (Owoicho *et al.,* 2021). Particulate matter (PM) or fugitive dust is the primary source of air pollution in quarries (Peter *et al.,* 2018).These quarry dusts significantly lead to production of considerable amounts of wastes harbouring a number of heavy metals which pose risks to human health. According to Oyinloye and Olofinyo (2017), the particulate air pollution especially inhalable particles PM_{10} is associated with a wide range of health effects. When inhaled, it affects the respiratory and cardiovascular systems, causes asthma which could lead to death.

Particulates from blasting and crushing areas are considered to be more dangerous, because they are occasionally inhaled deeply into the tracts, hence settling in areas where the body's natural cleaning mechanisms cannot remove them (Leon-kabamba *et al.,* 2020). Inhalation of dust and fumes bearing heavy metals severely affects the respiratory system, causing shortness of breath and destruction of mucus membrane (Godt *et al.,* 2006). Exposure to high concentrations of dust causes silicosis and fibrosis, a thickening of the lung walls leading to development of scar tissue (Jaishankar *et al.,* 2014).

CONCLUSION

The rate at which Quarrying activities affect human, plants, aquatic organism and even the environment within the Ebonyi State is a major source of concern. Hence, there is an urgent need to constantly re-evaluate quarrying activities and heavy metals contamination status at regional scale. This will help to avert several damages that heavy metals pose to human, plants and aquatic organisms and if possible reinstate water resources and soil to its natural state. Soil and food crop is affected by leaching of heavy metals from quarry waste within Ebonyi State.

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