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Assessment of Air Quality in the Vicinity of Mining Sites in Azare Developmenta Area, Nasarawa State, Nigeria

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Abstract: *The study aimed to assess the air quality in the vicinity of mining sites in Azara Development Area, Azara Nasarawa State. All Respirable Suspended Particulate Matter (RSPM values at the active mining sites exceeded NESREA limits of 250 µg/m^3 where Vein 2 had the highest value with an average of 808.81±33.18. with significant differences in all locations (P<0.05). The Total Suspended Particulate Matter (TSPM) was highest at the Kanji Copper site (2905.08±64.28). Heavy metal contents in RSPM of the four mining sites were below the NESREA permissible limits. Among the heavy metals, Pb concentration of 0.0689 mg/m^3 at the Vein 2 site and 0.0592 mg/m3 at the Vein 17 Sites exceeded WHO permissible limits of 0.05 mg/m^3. Consequently, the air component of the environment is affected by mining activities of the study area. The outcome called for regulatory measures.*

Keywords: *Noise level, Air quality, Environment, Mining sites, Regulatory measure.*

1. Introduction

Mining operations, a global phenomenon, have significantly contributed to environmental problems (Mkpuma *et al*., 2015; Khobragade, 2020). The devastation caused by mining and metallurgical activities to both terrestrial and aquatic environments has far-reaching implications (Ahange *et al*., 2014). Nigeria has abundant mineral resources, contributing immensely to the national wealth with associated socio-economic benefits. Some of the minerals, notably cassiterite (tin), columbite, tantalite, wolframite, lead, zinc, gold, coal, monazite, xenotime, zircon, thorite, and molybdenite have been exploited on a commercial scale and have made significant contributions to the revenue and socio-economic development of the country (Adedeji, 2014). Others include oil and gas, limestone, marble, and rock aggregates. They have been playing an increasing role in the national socio-economic development and growth because they generate appreciable internal revenue and foreign exchange earnings. (Aigbedon, 2007). Despite the economic benefits of mining, the industry harms the environment. Many communities across the six geopolitical zones of Nigeria where mining activities have taken place are negatively affected (Aigbedon, 2007). The environmental impacts include air, noise, water, and soil pollution, making the environment unsafe for living components, including plants, animals, and man. A major issue concerning the remedy or compensation for environmental damage resulting from mining and processing activities is that those who bear the costs of the environmental damage are the people who live in the environment and not the producing companies (Adekoya, 2003; Ahmad *et al.*, 2014). The study aimed to assess the noise level and air quality in the vicinity of mining sites in Azara Development Area, Azara Nasarawa State.

2. Methodology

2.1. Study Area

Azara Development Area is in the Awe Local Government of Nasarawa State, with an area of 2,557 km^2 and a population of 122,574 at the 2006 census. Azara is 50 - 66km from Lafia town, the capital of Nasarawa State; the study GPS location of latitude 8^0 22’ 21”N and longitude 009^0 22’ 08” E for Akiri, Latitude 8^0 22’ 21” N and longitude 008^0 22’ 00” E Azara, Latitude 8^0 22’ 21” N and longitude 008^0 22’ 40” E for Wuse and latitude 008^0 22’13” N and longitude 009^{0}17’33” E for Ribi study area. Mining activities are predominant in Azara area due to the abundance of salt, coal, barites, limestone, gemstone, iron and columbite (Ishaya *et al.*, 2018).

2.2. Sampling Techniques

The purposive sampling method was used to select sample locations within the Awe Development Area, which has four mining settlements: Akiri, Wuse, Ribi, and Azara. Across the settlements are mining sites, such as Vein 17 (site A), Vein 2 (site B), Chinese Copper Site (site C), and Kanji Copper Site (site C- an abandoned mining site). The Vein 17, Vein 2, and Chinese Copper Site were selected for study. The selection was made considering all the sites were operating and showed clear signs of degradation.

2.3. Air Quality Monitoring

The air quality in all the selected mining sites A, B, C, and D was monitored by a New, Improved Respirable Dust Sampler (Model: Envirotech APM 460NL) Airborne particulate matter was collected on a Whatman glass fiber filter paper (GF/A) 8 by 10 inches and loaded into a machine at each sampling site (Bhullar and Bhatnagar, 2019). Air quality monitoring parameters were computed based on Yadav and Rajamani's formula (2006). Air Volume Sampled (AVS) was calculated based on the formula given as: V= (QI + Q2)/2 * T (Where Q1= Initial air flow rate in m^3/min; Q2= Final air flow in m^3/min; T= Sampling time in minutes). The concentration of Respirable Suspended Particulate Matter (RSPM) and Non Respirable Suspended Particulate Matter (NRSP) was computed using the formula given by Yadav and Rajamani (2006): (Final weigh (wf) – Initial weight (Wi)/ Volume of air) * 106 (Wf= final weight of filter paper (g); Wi= initial weight of filter paper (g)). Total Suspended Particulate Matter (TSPM) = RSPM + NRSPM (μm/m^3).

3. Results

3.1. Air Quality Monitoring

Table 1 gives the results of the Suspended Particulate Matters present at different mining sites within the study area. The Respirable Suspended Particulate Matter (RSPM) of the locations as measured in μg/m^3 was highest at Vein 2 with an average of 808.81±33.18 followed by Vein 17 Site (744.70±10.9). The least amount was 426.03±54.16 recorded at Kanji Copper. Significant differences were found in the RSPM values of the four mining sites (P<0.05). All RSPM values exceeded NESREA limits of 250 μg/m^3. The concentration of Non-Respirable Suspended Particulate Matter (NRSPM) showed that Kanji Copper had the highest quantity (2480.18±27.49) while the Chinese Copper Site recorded the least (555.30±41.17). NRSPM values were 758.80±30.00 and 742.93±48.12 at Vein 17 and Vein 2 locations, respectively. Significant differences were found in the NRSPM values of the four mining sites (P<0.05). Values obtained exceeded NESREA permissible limits of 500 μg/m^3. Based on the Total Suspended Particulate Matter (TSPM) as obtained in μg/m^3, the Kanji Copper site had the highest quantity (2905.08±64.28), followed by the Vein 2 site (1567.61±55.05) and Vein 17 site (1487.63±57.67). Significant differences were found in the TSPM values of the four mining sites (P<0.05). Respiratory particles were lowest at Wadata but highest in Vein 2 sites. Non-respiratory particles had their highest value at the Wadata (>2000)) site but lowest at the Ben 1 site. The total suspended particles were very high. The highest TSPM was found at the Wadata (>2500) site and the lowest at the Ben 1 site (<1500).

Table 1. *Respirable, Non-Respirable, and Total Suspended Particulate Matter*

Mining Sites	Respirable Suspended Particulate Matter (RSPM) μg/m^3	Non-Respirable Suspended Particulate Matter (NRSP) μg/m^3	Total Suspended Particulate Matter (TSPM) μg/m^3
Vein 17	744.70±10.9^c	742.93±48.12^b	1487.63±57.67^b
Vein 2	808.81±33.18^c	758.80±30.00^b	1567.61±55.05^b
Chinese copper	623.29±32.54^b	555.30±41.17^a	1178.59±63.08^a
Kanji Copper	426.03±54.16^a	2480.18±27.49^c	2905.08±64.28^c
NESREA Limits	250	500	

^{a,b,c,d} *Mean with the same letter within a column are not significantly different at p < 0.05*

Table 2 presents the results of the heavy metal analysis in Respirable Suspended Particulate Matter (RSPM) of the four mining sites against WHO permissible limits. Zn was not detected at three mining sites, while in Vein 2 Site, RSPM contained 0.0028 mg/m3 of Zn, which was found below the WHO permissible limit of 5.0 mg/m^3. Cu was not detected in all samples from mining sites. The Cd was only found at Zoho Rami (0.0042 mg/m3) and Chinese sites (0.0012 mg/m3), and both fall below the permissible limit of 0.005 mg/m^3. Cr levels ranged between 0.0005 to 0.0151 mg/m^3 but below permissible limits in all samples. Pb concentration was 0.0689 mg/m^3 at the Vein 2 site and 0.0592 mg/m3 at the Vein 17 Site. These two highest Pb concentrations were recorded and exceeded WHO permissible limits of 0.05 mg/m^3. The Pb concentration of the two other locations was below the WHO limit. The highest concentration of Ni was 0.0381 mg/m^3 at Vein 2, followed by 0.0324 mg/m3 at Vein 17, but all Ni values were below WHO limits of 0.05 mg/m^3.

Table 2. *Heavy Metal Content in Respirable Suspended Particulate Matter (RSPM) of Mining Sites*

Heavy metal	Vein 17 Site Conc. (mg/m^3)	Vein 2 Site Conc.(mg/m^3)	Chinese Site Conc.(mg/m^3)	Kanji Site Conc.(mg/m^3)	WHO Limits Conc.(mg/m^3)
Zinc (Zn)	ND	0.0028	ND	ND	5
Copper (Cu)	ND	ND	ND	ND	1
Cadmium (Cd)	ND	0.0042	0.0012	ND	0.005
Chromium (Cr)	0.0108	0.0151	0.0008	0.0005	0.5
Lead (Pb)	0.0592	0.0689	0.003	0.0033	0.05
Nickel (Ni)	0.034	0.0381	0.0015	0.0243	0.05

ND= Not detected

4. Discussion

The Respirable Suspended Particular Matter (RSPM) in all mining sites exceeded the NESREA limit of 250 (μg/ m^3), whereas the RSPM of residential areas was very low. RSPM of the mining sites also exceeded the National Ambient Quality Standard (NAAQS) of 500 μg/ m^3 for industrial areas. Chaulya (2023) reported similar findings on air quality standards in mining sites. SPM and RPM were higher than the NAAQS in terms of his funding. High RSPM values may result in health risks such as cough, tumors, lesions, and whooping cough. It may also aggravate asthmatic conditions and damage respiratory tracks, which may lead to suffocation (Yadav and Rajamani, 2006). Particulate matters associated with mining activities have the potential to adversely affect the respiratory systems of humans through various forms of contact like the skin, oral ingestion, and inhalation (Aigbedion, 2005). High NRSPM values may result from human congestion and motorcycle movement, which can be linked to the nature of the road without asphalts layer, thus giving rise to a higher volume of dust. It was found above the NAAQS limit of 200 μg/ m^3 for residential areas. Many air-borne particulate matter is generated by stone crushing. When the air is laden with such dust, it causes health hazards for some people due to the dust-laden air that prevails within a few kilometers of the factories (Aguoru *et al.*, 2015).

Heavy metal concentration found in the study area shows that Pb concentration was 0.0689 mg/m^3 at the Vein 2 Site and 0.0592 mg/m3 at the Vein 17 site. These are the two highest Pb concentrations recorded, and they exceeded WHO permissible limits of 0.05 mg/m^3. The Pb concentration of the two other locations was below the WHO limit. The highest concentration of Ni was 0.0381 mg/m^3 at Vein 2, followed by 0.0324 mg/m3 at Vein 17, but all Ni values were below WHO limits of 0.05 mg/m^3. High lead concentration at Vein 2 and Vein 17 sites exceeded WHO permissible limits of 0.05 mg/m^3. This may pose health risks of kidney damage, cardiovascular disease, anemia, and neurodevelopment effects to workers and humans in the immediate environment, especially cases of lead poisoning. This position aligns with the report of Ojukwu *et al.* (2022), where the inhabitants of Kawo village in Kano State were exposed to lead and mercury poisoning of stream water as a result of gold mining, resulting in many fatalities. Also, there were instances of health risks associated with the illegal mining of lead that resulted in the poisoning and the death of 400 children in 2010 in Zamfara state in Northern Nigeria (Katz, 2010). Studies have shown, for example, that high concentrations of Pb found in animals near mining sites can be caused by animals foraging for plant material known to uptake Pb into their tissues (Macklin *et al.*, 2001; Reglero *et al.*, 2008). In the present work, the mean concentration of Nickel, Cadmium, and Chromium in RSPM falls within WHO permissible limits, but the present level may exceed the limits if not regulated.

5. Conclusion

The noise levels in all the mining sites within the study area were above the World Health Organization (WHO) guidelines limit of 70dB(A), whereas the abandoned mining site used as control recorded very low noise below WHO limits. RSPM and NRSPM in the study area were found above the NESREA limit. Out of the six heavy metals investigated in RSPM, only the Lead (Pb) level was found above the WHO permissible limit of 0.05 μg/ m^3 at two mining sites. The outcome called for regulatory measures.

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