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The Impact of Lead (Pb) Mining on the Bio-Ecosystem of Ishaigu Town of Ebonyi State, South-Eastern Nigeria

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Abstract
Open-pit mining of lead (Pb) in the Ishiagu region of Ebonyi State since 1965 has exposed large volumes of marcasites, pyrites and tailings contaminating the environment and food chain pathways. This research was designed to investigate the environmental impact of Pb mining on the bio-ecosystem of Ishaigu town and environs. Soil, water, biota, food, fish and quarry dust were collected between March and May 2018, processed and analysed for Pb concentrations. The results obtained showed that all the water samples exceeded WHO recommended safety limits for Pb (≤ 10 µg/L). Soil and food samples contained Pb levels above recommended values. Sampling of Ivo River, the main communal water source showed links to upstream pollution as the river passes through Pb mining fields. The result showed the negative impact of Pb mining in Ishiagu and the need for regulatory agencies/government to take measures to avert consequences of lead poisoning.
Keywords: Ishiagu, Impact, lead, pollution, mining

Introduction

Environmental pollution is a major global problem, where industrial, agricultural, mining and natural processes results in the release of toxicants into the environment. Lead (Pb) is a soft, dense and ductile metal found naturally in the environment, accounting for 0.0016% of the earth's crust [1]. However, due to its ubiquitous nature, it is used in several industrial processes like smelting of ores, soldering, battery and ammunition manufacturing, metal water pipes production, plastic stabilizers and in leaded petrol and paints. Several of these industrial processes often result to severe environmental pollution, leading to the increase of this toxic heavy metal in food, water, soil and air/dust beyond the acceptable limits and can invariably pass across food chains to animals and man [2].

Food contamination is one of the major routes of entry for toxic heavy metals into the biological system and therefore monitoring of these toxic metals in several media is always advocated for by regulatory agencies. Environmental exposure to Pb has long been recognized as a public health problem particularly among children [3]. Exposure to Pb is reported to be associated with a wide range of physiochemical and behavioural dysfunctions including neurodevelopmental anomalies, nephropathies, hypertension, impaired fertility and carcinogenesis [3].

The responsibilities of regulating Pb exposure include the setting up of acceptable levels in the environment and other media by regulatory agencies like the European Food Safety Authority (EFSA) of the European Union (EU), Food and Drug Administration (FDA) of the US and the Joint FAO/WHO Expert Committee on Food Additives (JECFA) and Nigeria's National Agency for Food and Drug Administration and Control [4,5,6,7]. These agencies in recognition of the public health significance of Pb poisoning, set recommended advisory or enforceable guidelines and demands regular and sustained risk assessments as a measure of maintaining "safe" levels. These guidelines are set to enable organisations and researchers carry out routine risk assessment studies and generate data and make it available to relevant authorities (or government) for policy formulations and decision making.

In 2010, about 400 deaths, especially among children under the age of five in Bukkuyum and Anka Local Government Areas of Zamfara State, Nigeria, were reported by Medecins Sans Frontieres (MSF, Holland) to the state health authorities [8]. The cause of the high mortality was acute and chronic Pb poisoning as a result of massive environmental contamination from artisanal mining and processing of gold in Pb-rich ore by poor herdsmen and farmers. This outbreak was reported as the worst in modern history [8]. Similar mining activities are on-going in Ishiagu town and environs of Ivo LGA of Ebonyi State, Nigeria, and the health risk from these activities have not been recorded. A decade ago, Duruibe *et al.* [9] reported the unwholesome nature of Ishiagu waters, especially due to high total dissolved solids, exceeding WHO tolerance levels. Informal investigation by the same team [9], reported other frequent health concerns like dullness, imbecility, irritability, madness among the locals that demand an investigation of the aetiologies. The objective of the present study was therefore, to carry-out a preliminary environmental risk assessment to investigate the environmental impact of Pb mining in Ishiagu town and environs of Ebonyi State, Nigeria.

Materials and Methods

The following reagents and equipment were used for the study; lead II nitrate [$Pb(NO_3)_2$] (AnalaR® BDH Poole UK), nitric acid (HNO_3) (Sigma®, Germany), perchloric acid ($HClO_4$) (Sigma®, Germany), hydrochloric acid (HCl) (Sigma®, Germany), magnesium nitrate hexahydrate ($Mg(NO_3)_2 \cdot 6H_2O$) (Sigma-Aldrich® India), de-ionised water prepared from distilled water, detergent (Omo® Nigeria), Samsung galaxy Tab 7.7 (Samsung® Inc., Vietnam), Dutch soil auger, aluminium block digester (Tecator® 40, Sweden), flame atomic absorption spectrophotometer (FAAS) (Buck Scientific®, East Norwalk, England), furnace (Tecator® 40, Sweden), crucible (Vycor® Somatco, KSA), borosilicate digestion tubes (Pyrex® Corning US), analytical balance (Mettler-Toledo® Inc. US). All reagents were of analytical grades.

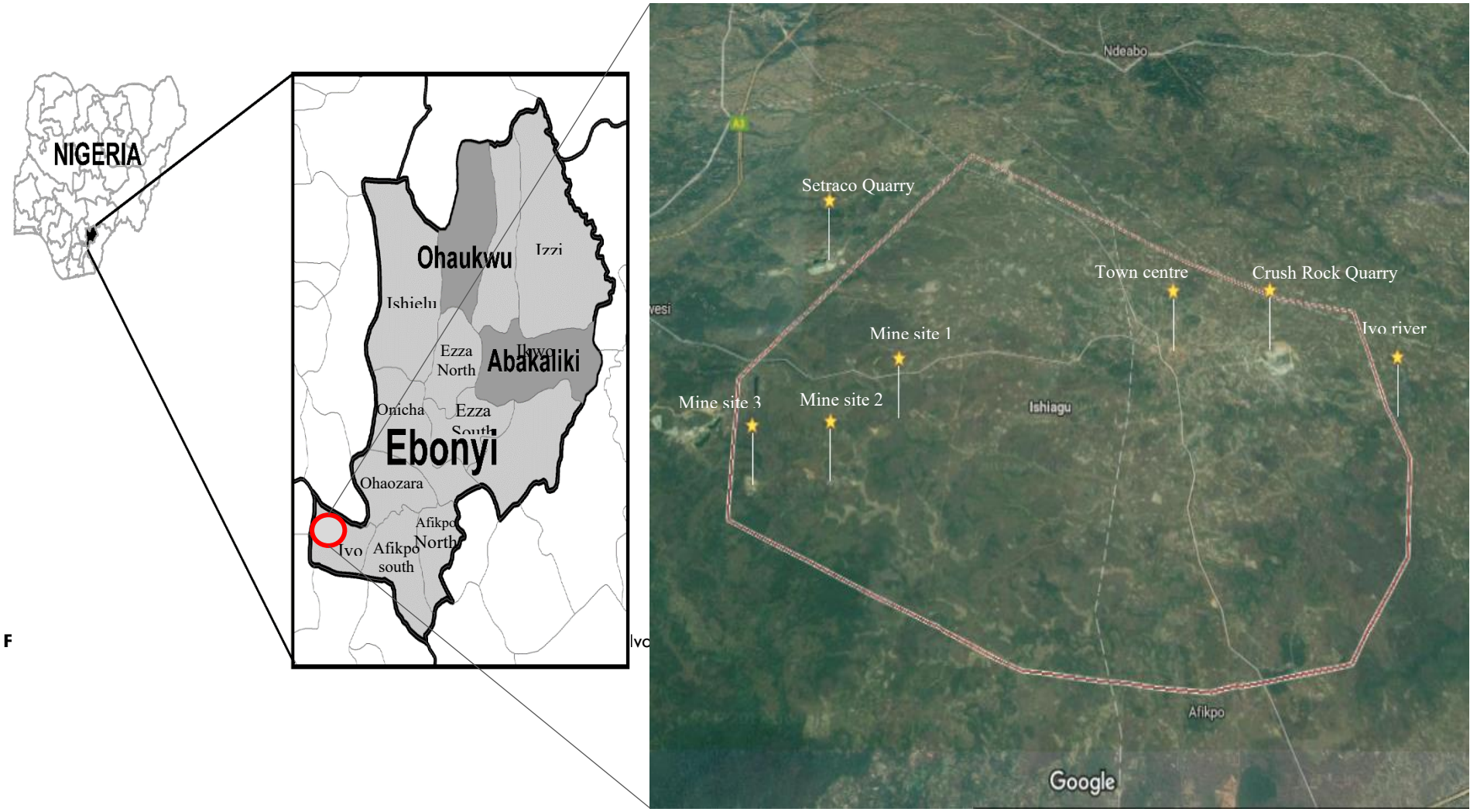
The investigation was carried out in Ishiagu town of Ivo Local Government Area of Ebonyi State, South-Eastern Nigeria. Ishiagu town is located between Latitudes 5°53' and 6°15' N and Longitude 7°29' and 7°35' E (Fig 1). It is a south-eastern town, populated primarily by the Igbo ethnic group with a population of about 198,793 people. The town experiences a tropical climate and an all-year-round rainfall with mean annual rainfall range of 1750 – 2000 mm and temperature range of 26.5 – 27.6 °C. The town is richly endowed with the following mineral deposits; argentite (AgS), sphalerite (ZnS), chalcopyrite ($CuFeS_2$), galena (PbS), siderite ($FeCO_3$), limestone ($CaCO_3$), cadmium sulphide (CdS) and granite [9, 10], and these minerals are intensively and competitively exploited by several mining industries and the locals.

Chain referral sampling method was used to sample sites of interest i.e. areas reported of high human/economic activities and mining or likely to be exposed to the impact of mining activities during the last 12 months (February 2017 to February 2018). Several samples (viz. water, soil, grasses/plant, food, fishes, domestic livestock tissues and quarry dust) were collected from Ishiagu villages between March and May 2018 and at each sample point, Global Positioning System (GPS) coordinates were recorded using Samsung Galaxy Tab 7.7® with Smart Tools App®.

The GPS coordinates were thereafter hyperlinked for location tracking. Plant samples collected were identified by a botanist of the Department of Wildlife and Range Management, Joseph Sarwuan Tarka University, Makurdi, Nigeria.

Dry- or wet-digestion method relative to the sample type was used to digest the various samples to release the Pb particles from their organic matter as described by AMAAS [11]. All digested samples were analysed in duplicate for Pb on a PerkinElmer® AAnalyst™ 800 flame atomic absorption spectrometer (FAAS) (PerkinElmer, Inc., Connecticut, USA) with an air acetylene flame and Pb cathode lamp at the Multidisciplinary Central Research Laboratory (MCRL), University of Ibadan, Ibadan, Nigeria. Actual concentration of Pb in the samples were determined as described by AMAAS [12].

One sample t-test was used to established whether there is significant effect of lead concentration across sample groups in relation to set permissible values by regulatory authorities. SPSS software® version 17 (IBM US) was used as the analytical package for the analytical tool.


NIGERIA
Ohaukwu
Izzi
Ishielu
Ezza North
Abakaliki
Ikwo
Onicha
Ezza South
Ebonyi
Ohaozara
Afikpo North
Ivo
Afikpo south
Ndeabo
Setraco Quarry
Town centre
Crush Rock Quarry
Ivo river
Mine site 1
Mine site 3
Mine site 2
Ishiagu
Afikpo
Google

F Ivo

Results and Discussion

Three (3) mine sites and quarry site 2 (Setraco Ltd) located about 11 kilometres away from the town and quarry site 1 (Crush Rock Industries Ltd) situated within the town were identified (see Fig 1 and Table 1). Samples were collected in communities around within the town away from the mine sites with their GPS coordinates (Table 2). A total of 66 samples were collected, comprising of soil (13), quarry dust (3), grasses (*mostly from Anthropogon gayanus, Pennisetum pedicellatum, Heteropogon contortus and imperata cylindrica*) (6), foodstuff (6), fish (6), livestock meat (4), water (21) and blood samples (7) representing 19.7%, 4.5%, 9.1%, 9.1%, 9.1%, 6.1%, 31.8% and 10.6% respectively

Table 1: Locations of Mining and Quarrying Activities at Ishiagu

S/No	Location	Approx. Distance (km) from the town	Location coordinates
1.	Village center	0	5°57'14.5"N 7°33'39.6"E
2.	Mine site 1 (lead & Zinc)	9	5°55'42.8"N 7°29'50.1"E
3.	Mine site 2 (lead & Zinc)	11	5°55'42.3"N 7°29'04.1"E
4.	Mine site 3 (Zinc)	7	5°56'15.6"N 7°30'17.2"E
5.	Quarry site 1 (Stones)	0	5°57'14.8"N 7°34'42.5"E
6.	Quarry site 2 (Stones)	11	5°58'21.0"N 7°29'48.5"E

Results of Pb assessment around Ishiagu town are presented in Table 2. Among the soil samples, sample ID IS040 and IS119 from the bank of River Ivo showed the highest Pb concentrations of 1295.00±0.00 and 695.00±17.50 mg/kg respectively, with the least Pb concentrations in the soil collected around quarry site 1 (sample ID IS032). Among the grasses collected, only one showed high level of Pb concentration with 68.38±0.53 mg/kg (sample ID IS131). Food substances comprising of cassava, Ugu leaves (*Telfairia occidentalis*), okra seeds and banana, showed high Pb concentration more in the Ugu leaves and okra seeds with values of 41.88±1.59, 49.15±0.18 and 68.38±0.53 mg/kg respectively (sample IDs IS042 and IS043, IS044). Fish sampled from fishermen on the bank of Ivo River in Okue community gave a Pb mean concentration of 15.96±15.50 mg/kg. But livestock meat collected in Eke market in the heart of Ishiagu town revealed no detectable Pb concentration in all the samples. Twenty-one (21) water samples collected from both surface (rivers, streams, ponds, pools) and deep (wells, boreholes) water sources had the highest Pb concentration of 4912.50±123.74 µg/L (sample ID IS051) from a household water sourced from Ivo River. Blood samples collected from domestic animals (sheep and goat) showed mean Pb value of 16.21±22.14 µg/L with a range of 0.00 – 56.00 µg/L.

Table 2: The Impact on the Eco-System of the Lead Mining Activities on Ishiagu Town

ID	Sample type	Location description	Conc.±SD (mg/kg)	Location coordinates
IS040	Soil sediment	Bank of River Ivo in Okue	1295.00±0.00†	5°56'25.6"N 7°35'45.6"E
IS119	Soil	Bank of River Ivo in Okue	695.00±17.50†	5°56'25.6"N 7°35'45.6"E
IS019	Soil	Playground, Amaonyenye Pri Sch	298.25±2.75	5°56'20.9"N 7°32'51.9"E
IS120	Soil	Playground, Okue Community	62.38±1.59	5°56'45.5"N 7°34'37.6"E
IS121	Soil	Playground, Amokwe Community	31.25±1.77	5°57'19.3"N 7°33'49.2"E
IS141	Soil	Playground, Amonye Community	45.63±0.88	5°57'08.0"N 7°33'27.2"E
IS142	Soil sediment	Borehole at St Anthony Catholic Church	112.62±0.18	5°57'12.7"N 7°33'35.7"E
IS133	Soil sediment	Community well at Amonye Community	47.38±0.88	5°57'05.9"N 7°33'26.1"E
IS134	Soil sediment	Community well, Amagu Community	168.37±0.53	5°56'28.5"N 7°33'30.9"E
IS139	Soil sediment	Community well, Amaeze Community	125.63±0.18	5°57'10.9"N 7°33'51.3"E
IS023	Soil	Perimeter fence of quarry site 1	21.13±1.24	5°57'20.3"N 7°34'42.8"E
IS032	Soil	Farmland on perimeter of quarry site 1	18.88±0.18	5°56'58.4"N 7°34'48.1"E
IS122	Soil sediment	Beside a village quarrier	62.38±1.60	5°57'20.1"N 7°34'38.9"E
IS025	Quarry dust	Village quarrier around quarry site 1	68.38±0.53	5°57'20.1"N 7°34'38.9"E
IS118	Quarry dust	Perimeter fence of quarry site 1	57.88±6.89	5°57'20.3"N 7°34'42.8"E
IS123	Quarry dust	Village quarrier around quarry site 1	57.63±6.19	5°57'20.1"N 7°34'38.9"E
IS039	Grasses	Bank of River Ivo in Okue	ND	5°56'41.5"N 7°34'50.0"E

IS027	Grasses	Ikeh River 400 m from quarry site I	ND	5°58'10.2"N 7°36'33.4"E
IS131	Grasses	Farmland 200 m from quarry site I	68.38±0.53†	5°58'10.2"N 7°36'33.4"E
IS132	Grasses	Farmland 200 m from quarry site I	23.00±20.86	5°58'10.2"N 7°36'33.4"E
IS129	Grasses	Perimeter fence of quarry site I	176.38±0.18	5°57'20.1"N 7°34'43.1"E
IS132	Grasses	Perimeter fence of quarry site I	23.00±20.86	5°57'20.1"N 7°34'43.1"E
IS034	Cassava	Farmland near River Ivo in Okue	22.00±1.06†	5°56'25.6"N 7°35'45.6"E
IS038	Cassava	Farmland on bank of River Ivo in Okue	17.50±0.35†	5°56'25.6"N 7°35'45.6"E
IS042	Ugu leaves	Eket-nteh market in Okue	41.88±1.59†	5°56'41.5"N 7°34'50.0"E
IS043	Ugu leaves	Eket-nteh market in Okue	49.15±0.18†	5°56'41.5"N 7°34'50.0"E
IS044	Okra seeds	Eket-nteh market in Okue	68.38±0.53†	5°56'41.3"N 7°34'50.2"E
IS082	Banana	Playground, Amonye Community	9.63±1.59†	5°57'05.9"N 7°33'26.1"E
IS083	Fish	Fishermen on the bank of River Ivo	15.88±0.18†	5°56'25.6"N 7°35'45.6"E
IS084	Fish	Fishermen on the bank of River Ivo	45.50±1.41†	5°56'25.6"N 7°35'45.6"E
IS085	Fish	Fishermen on the bank of River Ivo	20.88±1.24†	5°56'25.6"N 7°35'45.6"E
IS086	Fish	Fishermen on the bank of River Ivo	5.63±1.94†	5°56'25.6"N 7°35'45.6"E
IS087	Fish	Fishermen on the bank of River Ivo	7.50±0.35†	5°56'25.6"N 7°35'45.6"E
IS088	Fish	Fishermen on the bank of River Ivo	0.38±0.53†	5°56'25.6"N 7°35'45.6"E
IS094	Cow meat	Eke market Ishiagu	ND	5°57'14.1"N 7°33'39.5"E
IS095	Cow meat	Eke market Ishiagu	ND	5°57'14.1"N 7°33'39.5"E
IS096	Goat meat	Eke market Ishiagu	ND	5°57'14.1"N 7°33'39.5"E
IS097	Goat meat	Eke market Ishiagu	ND	5°57'14.1"N 7°33'39.5"E

ID	Sample type	Location description	Conc.±SD (µg/L)	Location coordinates
IS020	Surface water	Stream 200 m from Amaonyenye Pri Sch	1225.00±35.36†	5°56'12.1"N 7°32'46.4"E
IS022	Well water	Communal well at Freedom Hotel, Ishiagu	625.00±35.36†	5°57'04.0"N 7°34'20.3"E
IS035	Surface water	bank of River Ivo in Okue Community	1412.50±53.03†	5°56'25.0"N 7°35'46.2"E
IS036	Surface water	River Ivo in Okue Community	562.50±17.68†	5°56'25.0"N 7°35'46.2"E
IS037	Surface water	River Ivo in Okue Community	1562.50±53.03†	5°56'25.0"N 7°35'46.2"E
IS041	Surface water	Household drinking water from River Ivo	1812.50±17.68†	5°56'37.7"N 7°34'59.2"E
IS045	Well water	Community well in Amaeze Community	2787.50±123.74†	5°56'28.5"N 7°33'30.9"E
IS047	Well water	Community well, Amagu Community	4625.00±70.71†	5°57'10.9"N 7°33'51.3"E
IS048	Well water	Community well, Amagu Community	4850.00±35.36†	5°57'14.7"N 7°33'49.6"E
IS049	Well water	Community well, Amagu Community	4625.00±106.07†	5°57'14.7"N 7°33'49.6"E
IS051	Surface water	Household water from River Ivo	4912.50±123.74†	5°57'14.7"N 7°33'49.6"E
IS052	Well water	Community well, Amagu	1737.50±53.03†	5°57'10.9"N 7°33'51.3"E
IS076	Surface water	Iyioku River in Ihietutu Community	2650.00±0.00†	5°56'52.8"N 7°32'34.2"E
IS077	Surface water	River Ikwo in Ihietutu Community	2662.50±53.03†	5°57'07.2"N 7°33'04.0"E
IS078	Well water	Borehole at St Anthony Catholic Church	3800.00±0.00†	5°57'12.7"N 7°33'35.7"E
IS079	Well water	Private well in Egbe, Amonye	ND	5°57'05.9"N 7°33'26.1"E
IS080	Well water	Community well at Amonye Community	2975.00±70.71†	5°57'05.9"N 7°33'26.1"E
IS081	Well water	Borehole at Eke market	3262.50±17.68†	5°57'15.0"N 7°33'40.0"E
IS024	Surface water	Akwukwuo stream near quarry site I	ND	5°57'20.1"N 7°34'43.1"E
IS028	Surface water	Ikeh River 400 m from quarry site I	1437.50±53.03	5°58'10.2"N 7°36'33.4"E
IS031	Surface water	Akwukwuo stream near quarry site I	ND	5°56'56.9"N 7°34'41.9"E

ID	Sample type	Location description	Conc.±SD (µg/dL)	Location coordinates
IS108	Ovine blood	Household, Okue Community	13.00±1.41†	5°56'38.1"N 7°35'05.7"E
IS113	Ovine blood	Household, Okue Community	2.00±0.00	5°56'37.7"N 7°35'02.4"E
IS114	Ovine blood	Household, Okue Community	25.00±1.14†	5°56'40.2"N 7°34'53.4"E
IS109	Caprine blood	Household, Okue Community	1.00±0.00	5°56'38.1"N 7°35'05.7"E
IS110	Caprine blood	Household, Okue Community	5.00±0.00	5°56'37.7"N 7°35'02.4"E
IS111	Caprine blood	Household, Ihietutu Community	ND	5°57'07.8"N 7°33'09.7"E
IS112	Caprine blood	Household, Ihietutu Community	7.00±0.00	5°57'07.8"N 7°33'09.7"E

Recommended guidelines **(1)** WHO guideline for lead in drinking water ≤ 10 µg/L (0.01 mg/L) **(2)** US-EPA guideline for lead in soil ≤ 400 mg/kg **(3)** EFSA guideline for lead in food ≤ 3 mg/kg, (4) FAO guideline for lead in drinking water for livestock ≤ 0.1 mg/L, **(5)** EU guideline for lead in animal feed ≤ 30 mg/kg, (6) CDC guideline for lead in blood ≤ 10 µg/dL, Conc. = Concentration, SD = standard deviation, ID = sample identity, ND = not detected, † = values greater than the recommended values

Artisanal mining activities are known to cause environmental pollution and contamination of food chain pathways [13]. Heavy metal toxicity is one of the oldest environmental problems and remains a health challenge in many developing and industrialized nations [14]. Mining of Pb and Zn in Ishiagu is reported to generate abandoned stockpiles of marcasites, pyrites and tailings, containing large quantities of heavy metal ores like chalcopyrite ($CuFeS_2$), galena (PbS), sphalerite (ZnS), argentite (AgS), siderite ($FeCO_3$), limestone ($CaCO_3$) and cadmium Sulphide (CdS), contaminating the surrounding environment. Though, mining and quarrying activities are still on-going, scanty information exists on the impact on the bio-ecosystem. During our visit *ab initio*, we observed that mining and quarrying sites were at elevated lands, thus facilitating run-offs of dissolved heavy metals during rains, contaminating farms and water bodies. The pollution problems at Ishiagu were observed to be compounded by unwholesome practice of miners pumping mine effluents/spoils into surrounding fields. And as a result, our findings showed severe environmental contamination especially of water sources, where almost 100% of water samples assessed have Pb levels exceeding WHO permissible limits of Pb in drinking water for humans (10 µg/L) and animals (100 µg/L) [15].

Environmental pollution via mining activities around Ishaigu was previously reported by Eze and Uko [10] and Duruibe *et al.* [9], where they observed acid mine drainage (AMD), acid rain and unwholesome nature of Ishaigu waters due to increased total dissolved solids (TDS). This was observed in several water sources around Ishiagu town heavily laden with the heavy metal Pb, as a result of mining and processing of galena. It is worthy to note that, since the decline in atmospheric emission of Pb through automobile industries due to changes in the legislation of several countries on it use in petrol; Pb-laden paints, Pb-soldered water pipes and artisanal mining has become the largest and the most common source of Pb environmental contamination and human/animal exposure [16] as seen in this report.

Mining activities were observed to be located some kilometres away from the town centre (Table 1) where human population and activities are low, however, the aftermath of environmental pollution around the sites are observed to be affecting the town, probably because of downstream pollution of water bodies upstream. This assertion was supported by samples from Ivo River where analysis revealed soil, water, food and fish samples having Pb concentrations significantly above permissible levels. Our result shows the negative impact of mining activities elsewhere, impacting negatively on Ishaigu communities like Okue, Obada and Amagu; because they fetch their waters for domestic use from Ivo River (sample ID IS036 and IS037). However, water samples collected from Akwukwuo stream, a tributary of Ivo River, show no detectable Pb levels (sample ID IS024 and IS031) compel with water samples from River Ivo with high Pb content above guideline values (sample ID IS036 and IS037). This result agrees with earlier findings of of Chima *et al.* [17] who reported no Pb levels amongst other metals in Akwukwuo stream that drain its waters into River Ivo. This confirmed our earlier assertion that contamination of Ivo River waters by Pb, may be due to downstream pollution from unwholesome mining practices upstream. Other water sources around town were also observed to be contaminated with Pb. All wells and borehole waters except a private well in Egbe, Amonye Community (sample ID IS079) showed high Pb content above the WHO guideline for Pb in drinking water. This result showed that there was also severe underground contamination of well and borehole water sources and this could be an indicator of underground water Pb pollution. Such severity of environmental pollution as seen here is of great public health concern to many regulatory agencies and nations [5].

Our results also revealed the tremendous downstream contamination of the bio-ecosystem as seen in the blood, food and fish sampled within Okue community having appreciable Pb concentrations above permissible levels. Blood samples from domestic animals in 2 communities (Okue and Ihetutu) revealed animals from Okue Community having blood lead levels (BLLs) of concern (IS108 and IS114), above the CDC Pb monitoring value of 10 µg/dL [[7]. This was attributed probably to their source of water, the Ivo River. Furthermore, blood samples from Ihetutu community which source their water from Iyioku and Ikwo streams, observed to be heavily laden with Pb (IS076 and IS077), also showed increased BLLs, though below tolerable levels. This anomaly was linked to their source of water.

Among the soil samples collected around Ishiagu town, two (sample ID IS040 and IS119) did not meet the US EPA guideline for Pb in soils by having Pb concentrations of 1295.00±0.00 and 695.00±17.50 mg/kg respectively above the permissible values of 400 mg/kg. The soil samples were collected on the bank of River Ivo, which was indicative of probable downstream pollution by upstream mining activities. This report agrees with the work of Duruibe *et al.* [7] and Eze and Uko [10], who reported the effects of marcasite and tailing from abandoned mine pit, generating acid mine drainages (AMD), polluting soil and waters bodies. Investigations also revealed the contribution of dry season irrigation farming at the bank of Ivo River to contamination of vegetables by Pb. Ugu leaves (*Telfairia occidentalis*) and Okra, though, sampled in Eket-nteh market, showed Pb concentrations above permissible levels (i.e. 3 mg/kg). Informal interviews with vendors of these food stuffs revealed their source to be from farms on the bank of Ivo River. This *ab initio* was linked to the high Pb content of Ivo River waters (sample ID IS035, IS036, IS037 and IS041, Table 2) used by farmers for irrigational farming on the bank of the river. The health hazard of consuming Pb-laden vegetable cannot be overemphasized and was reported elsewhere by Ibukun *et al.* [18]. Food chain contamination is a major health concern and monitoring of heavy metals in soil, foodstuff and drinking water both for humans and animals is seriously advocated by regulatory agencies [20]. Bioaccumulation of Pb in food and feed substances is reported to pose serious toxicological risk as transfer to animals and subsequently humans pose a great public health concern [16]. The result obtained in this study apparently requires that urgent attention be given to avert cumulative effects of low-level Pb intake from contaminated sources of Ishiagu community and for the government of Ebonyi State to institute policies to avert both acute and chronic effects of Pb exposure to the human and animal population as

reported in Zamfara State, Nigeria by Medecins Sans Frontieres (MSF) [8].

Conclusion

This study has revealed a significant and widespread environmental contamination resulting from prolonged lead (Pb) mining activities in Ishiagu town, Ebonyi State, Nigeria. The concentrations of Pb in water, soil, food, vegetation, fish, and even animal blood samples overwhelmingly exceeded the safety thresholds established by global health and regulatory agencies, including WHO, US-EPA, and CDC. Particularly alarming were the Pb levels found in water sources such as the Ivo River and several wells, suggesting both surface and underground contamination, likely exacerbated by unregulated mining effluents and terrain-facilitated runoff. Evidence of bioaccumulation in edible plants, fish, and animal blood underscores the health risks to local communities who depend on these environmental resources for sustenance. The findings confirm the downstream impact of upstream mining operations, pointing to a clear link between artisanal mining activities and ecological degradation. These observations not only reflect environmental and public health emergencies but also highlight regulatory lapses in the enforcement of environmental protection policies. Urgent and coordinated action is required from local, state, and national authorities to implement effective remediation strategies, monitor Pb levels continuously, and educate affected communities. Without intervention, the cumulative health effects of chronic Pb exposure may escalate, mirroring the tragic consequences previously seen in other mining-impacted regions of Nigeria.

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