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RESEARCH ARTICLE

ENVIRONMENTAL IMPACTS OF IRON ORE MINING ON QUALITY OF SURFACE WATER AND ITS HEALTH IMPLICATION ON THE INHABITANTS OF ITAKPE

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ABSTRACT

Environmental impact of Iron ore mining on quality of surface water and Health of the inhabitants of I takpe, Nigeria was investigated. Since the commencement of iron ore mining in Itakpe in 1979, water related problems have been experienced by the inhabitants of the area. 90 households were chosen at random from Itakpe, Abobo and Eika-Adagu communities to answer questions on water-health related problems that they have experienced since the inception of iron ore mining in the region. The result shows different water-health related problems being experienced by the people; these include dry skin, gastro-intestinal irritation, turning of yam and cassava into black when cooked with water from the stream, metallic tasting of water, rusty stains on laundry, coloration of teeth (red-brown), red-brown stains on ceramic plates and pots. Laboratory analysis was carried out on water samples collected from Eika-adagu River, the only sources of surface water supply that drains the iron ore mining region. Two samples were collected each from the upstream before the mining region and downstream sections after the mining region. The analysis shows considerable / substantial contents of chemical pollutants, with iron (fe) constituting the highest percentage of the pollutants and Cendium (Ce) constituting the lowest percentage of the pollutants. The other chemical pollutants found are; Lead (Pb), zinc (Zn), copper (Cu), and Chromium (Cr). Based on the field survey, for consuming the water, the study shows that, about 44.4% of the people from the three communities have suffered gastro-intestinal irritation, 21.1% suffered catharsis, 53.3% suffered dehydration, 54.4% suffered dry skin condition, 100% confirmed the incident of stains on ceramics, rusty stains on laundry, and metallic tasting of the water from river Eika- Adagu, 42.2% suffered coloration of teeth, 100% also confirmed that when tubers like yam and cassava are cooked with the water, they turn lack.

INTRODUCTION

Background To The Study

Iron Ore mining activities have major impacts on the quality of environmental resources, and thus on the value that people can derive from such resources. The mining of iron ore causes irreversible conditions to the ecosystem, general disturbance of underground water system, pollution of surface water thereby causing inadequate water supply or non availability of portable water to the people living in the area. Iron is the second most abundant metal in the earth's crust, it accounts for about 5%. Elemental iron is rarely found in nature, as the iron Fe^{2+} and F^{3+} readily combine with oxygen- and sulfur- containing compounds to form oxides, hydroxides, carbonates and sulfides. Iron is most commonly found in nature in the form of its oxides (Knepper, 1981) and (Elinder, 1986).

The average lethal dose of iron is 200-250mg/kg of body weight, but death has occurred following the ingestion of doses as low as 40mg/kg of body weight, National Research Council Baltimore (NRCB, 1979). Autopsies have shown haemorrhagic necrosis and sloughing of areas of mucosa in the stomach with extension into the submucosa. Chronic iron overload results primarily from a genetic disorder (haemochromatosis) characterized by increased iron absorption and from diseases that requires frequent transfusions Bothwell *et al*, (1979).

Water polluted by heavy metals like Iron, Copper, Lead and Zinc has become a striking problem because of its health consequences on the inhabitant (Rasheed *et al*, 2014). Particularly where the people depend on the surface water like streams or rivers for their water supply or water need. In Itakpe the study area, the only source of surface water supply is the

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Eika-Adagu River that drains through the three major mining communities which are Eika-Adagu, Abobo and Itakpe.The World Health Organization (WHO) estimated in 1996 that in every eight seconds, a child dies from water related diseases and that each year more five million people died from illness related to unsafe drinking water or inadequate sanitation (Shivaraju, 2012). Investigating the consequences of heavy metal pollution has become a global issues because of the danger these elements portent for plants, animals and human health (Oyekunle *et al*, 2012)

According to Akpah (2004), in a research carried out on the qualities of underground in Itakpe found out that the water hardness value was between 56.66mg/l and 182.53mg/l which was less than the WHO (2004) permissible limit of 500gm/l. he pointed out the negative consequences of such result to include; soap stain and forming curds on fabrics, causing the threads to become bristles and shortening the life of the material, wastage of soap and synthetic detergents, soap scum rings in the bathtub, build up of scale deposits in all water using appliances, clogs hot water pipe and reducing the heating efficiency of a boiler or water heater. He stressed that the ground water shows high concentration of iron value much higher than the WHO (2004) recommended and maximum permissible limits of 0.3mg/l, as the result he got 1.628mg/l

The removal of this crustal mineral (Iron Ore) which is use for the production of steel and for the manufacturing of automobiles, machineries, aircraft engines, electrical appliances, construction of bridges and rail lines often attract little or no effort from the mining organization to reverse or reclaim the distorted environmental resources like water and soil thereby leaving the inhabitants of the area with little or no option than to make use of what is available, in this case surface water in the form of rivers or streams. The people are often confronted with the various type of water related problems and diseases such as Catharsis, dehydration and gastro-intestinal irritation (Khair, 1994). Copper accumulates in the liver and impairs the taste of the water (Khair, 1994). According to World Health Organization, excess zinc in the body is hazardous, because it causes liver damage and even death (WHO,1984). The dominant among the heavy metals in the region which is Iron Ore is known to interfere with normal body fluid regulation and can also precipitate as the oxide occurring as stains on materials that comes in contact with it (Samananth and Muthikrishnam, 1990).

The extent of damages done to the inhabitants of this mining communities due to heavy pollution of surface water (Eika-Adagu river) by heavy metals like Iron, Copper, Cendium , Zinc and Lead have not been investigated for the past Thirty six years of continuous mining activities in the area, hence the need and justification to carry out this study. The objectives of this study therefore is to find out the level of surface water pollution and the health problems associated with such pollution that has taken place over the years.

The Study Area

Itakpe Iron ore mining region is located within Okehi Local Government Area of Kogi State. Itakpe has common boundaries with Lokoja to the North, Kabba/Ijumu to the west, Adavi (Ogaminana) and Okene to the south and Ajaokuta to the east. Itakpe lies between latitudes 7015'N and $7^{0}58^{'N}$ and on longitude 6^{0E} and $6^{0}47^{'E}$. Itakpe is surrounded by ridges of hills with average height of about 360metres above mean sea level (Fadare, 1980). Itakpe area is underlain by Precambrian rocks which form more than 70% of the rocks in the area.

The climate is characterized by alternate wet (April-October) and dry (November-March) seasons. The area has an average annual rain fall of 1300mm with high relative humidity in January and in July. Itakpe is characterized by an average surface temperature of about 30^{0c}, with evaporation rate of 700mm between April and October. This climatic condition has a remarkable effect on the alternate intensive heat in dry season and torrential rainfall usually accompanied by cold conditions in the wet seasons. A number of rivers took their sources from Eika hills and discharge their contents into river Niger. These rivers include; Eika-Adagu, Osara river, River Ero and their tributaries. All these rivers are seasonal except Eika-Adagu River.

Generally the topography is characterized by ridges of hills and undulating plains with relative low slope angle. The soil is that of ferrallitic soils. These are climtogenic soils of areas in the ecotone between rainforest and guinea savanna. The soils reflect the final stage of weathering and leaching, where the immobile and un-weatherable constituents remain. Iron stone and gravel are common in the soil profile.The vegetation falls within the Guinea savanna Zone and specifically belong to parkland savanna that is found in the transition zone between the high forest and guinea savanna (Illoeje, 1984). I takpe land is mostly used for subsistence farming. The hill slopes and the plains are intensively cultivated by the indigenes (Ebira people) of the area. The crops grown in Itakpe are mainly food crops. These include Millets, Sorghum, Maize, Yam, sweet Potato, Guinea corn, Cocoyam, Cassava, Melon and Beniseed.

METHODS AND MATREIALS

In order to collect information on the environmental impact of iron ore mining onquality of surface water and its health implication on the people around the mining region, two water samples were collected from river Eika , which serves as the major surface water supply to the people in the area. Along the river, a sample was collected from the upstream before the mining region and a sample collected after the mining region. Laboratory standard procedures were followed to analyze the water samples.

Well structured ninety (90) questionnaires were used to collect information on the water-health related problems encountered by the people in the region over the years. The region was divided into three, based on settlement areas, these areas are Eika Adagu, Abobo and Itakpe mining camps. These ninety questionnaires were divided into thirty (30) each for these settlement areas and were administered using random sampling techniques. The result was collated and analyzed.

RESULTS AND DISCUSSION

From the laboratory analysis carried out on water quality samples taken from Eika stream, the study revealed that the upstream section was minimally polluted with chemical (metallic ores) pollutants, while the downstream section of the river was heavily polluted with chemical pollutants resulting

from iron ore mining and beneficiation activities. The major pollutants are lead (Pb), Copper (Cu), Iron (Fe), Zinc (Zn), and Cendium (Cd).

Lead

Lead (Pb) is 4.0mg/l upstream and 12.0mg/l downstream, when compared with World Health Organization(WHO) guidelines for portable water the value is quite high for the acceptable limit for drinking water which is (0.01mg/l). The effects of lead are the same whether it enters the body through breathing, water intake or swallowing, it's capable of affecting every parts of the body especially nervous system in both adult and children (UNEP/OCHA, 2013).

Copper

Copper is absent at the upstream and account for 4.5mg/l downstream, this shows that during mining and beneficiation activities, materials containing copper must have been introduced into the environment and eventually ended up in the river. When compared with WHO guidelines for portable water of the recommended 2.0mg/l, the value gotten in this study is too high for human consumption. According to Lokeshappa etal (2012), copper is an essential substance for life, but its critical doses can cause anemia, acne, adrenal hyperactivity and insufficiency , allergies, hair loss, arthritis, cancer depression, elevated cholesterol, diabetes, kidney and liver dysfunction.

Zinc

Zinc is not present at the upstream, based on the laboratory analysis, but showed its heavy presence at the downstream with 16.0mg/l. This value surpass the recommended value of 5.0mg/l for portable and safe water for drinking (Rasheed etal, 2014).

Iron

Iron ore (Fe) is 0.4mg/l upstream and 15.6mg/l downstream which indicates heavy pollution of the stream, the analysis showed high concentration of iron both at the upstream and downstream. This may be due to high deposition of iron ore in the region. Iron ore mining on a large scale is the major economic activities going on in the region. The value found on the surface water is far above the WHO recommended value of 0.36mg for a drinkable water. This makes the surface water in the region unsafe for drinking.

Chromium And Cendium

Chromium (Cr) was absent both upstream and downstream while Cendium (Cd) is 0.06 upstream and 0.16 downstream, which also show that chromium is also a major pollutant of surface water in Itakpe and its environs. All these pollutant may have been introduced into river Eika due to prolong iron ore mining in Itakpe.

Table 1 Data On Water Quality And Quantities Of Chemical Pollutants In Mg/L On Eika River (A Surface Stream) In Itakpe, Resulting From Iron Ore Mining.

Stream section	Ph level	Color	Odour	Chemical p0llutants in mg/l					
				Pb	Cu	Zn	Fe	Cr	Cd
Upstream	6.5	Colorless	Odorless	4.0	Abs	Abs	0.4	Abs	0.06
Down stream	7.8	Reddish brown	Odorless	12.0	4.5	16.0	460	Abs	0.16

Field Survey; Nov, 2015.

The major sources of water for drinking in the study area according to the respondents are, stream, well and rain water. A total of 54 respondents across the three settlement areas representing 60% uses stream water for domestic activities including drinking, 15 respondents representing 16.6% uses well water while 24 respondents representing 26.6% depend on rain water during rainy season and result back to either surface stream or well, see table 2 below.

Table 2 Source Of Drinking Water In The Study Area

Sources	Abobo	Eika-adagu	Itakpe	Total	Percetage
STREAM	17	18	19	54	60%
WELL	3	4	8	15	16.6%
RAIN	10	08	05	24	26.6%

Occupation of The Inhabitant of Itakpe

The analysis of the structured questionnaire showed that a total of 15 respondents representing 16.7% across the region are farmers, 23 respondents representing 31.1% are civil servant, 7 respondents representing 7.7% are artesians, 14 respondents representing 15.6% are traders, and 18 respondents representing 20% are miners while 8 respondents representing 8.9 are students

Table 3 Occupation of The Inhabitants Of Itakpe

Occupation	Abobo	Eika	Itakpe	Total	Percentage
Farming	7	5	3	15	16.7%
Civil Servant	6	12	10	23	31.1%
Artesian	4	1	2	7	7.7%
Trader	5	3	6	14	15.6
Miner	6	4	8	18	20%
Student	2	5	1	8	8.9

Field Survey: 2015

Incidences of Water-Health Related Problems

Due to a prolong consumption of heavily polluted Eika river as a major sources of water supply by the inhabitants of the area, where a lot of iron ore mining is taking place, this study shows that most respondents suffers more than one health challenges resulting from consuming the surface water in the region. The analysis shows that a total number of 40 respondents, representing 44.4% have suffered gastro- intestinal disorder, 19 respondents representing 21.1% have suffered catharsis, a condition that involve serious purging, that may result to death if not handled immediately, 48 respondents representing 53.3% have experience dehydration, 49 respondents representing 54.4% have suffered dryness of skin after taken their bath with the water from the stream. 51 respondents representing 56.6% have experienced stubborn stains on their ceramics while 60 respondents representing 66.6% have experienced rusty stains on their laundry after using the water for washing for a long time. 48 respondents representing 53.3% attest to the fact that the water from the stream has a metallic taste. About 38 respondents representing 42.2% have suffered coloration of their teeth after drinking the water for several years. 39 respondents representing 43.3% said when the water is use for cooking yam or cassava, they turns blackish, 8 people representing 8.8% have cases of cancer/ulcer which they claimed had the disease due to the consumption of iron polluted water as a result of mining activities in the region. 20 respondents representing 22% have experience of water hardness which in most cases makes them to spend more

detergent while washing their clothing material, even where water is meant to be heated, it takes more time to boil than when the water is not hard.

Table 4 Incidence of Water Related Health Problems

Heaith problems	Abobo	Eika-adagu	Itakpe	Total	Percentage
Gastro-intestinal irritation	15	13	12	40	44.4%
Catharsis	6	5	8	19	21.1%
Dehydration	15	14	19	48	53.3%
Dry Skin	14	20	15	49	54.4%
Stains on Ceramics	20	18	13	51	56.6%
Rusty Stains on Laundry	17	24	19	60	66.6%
Metallic tasting	13	17	18	48	53.3%
Coloration of teeth	10	15	13	38	42.2%
Tubers turns black	14	16	9	39	43.3%
Incidence of Cancer/Ulcer	2	3	3	8	8.8%
Water Hardness	5	8	7	20	22.2%

CONCLUSION

According to Reynolds (2007), today's technology provides the ability to treat water down to its basic atomic structure of H_2O however the cost associated with the production of water purification to this level will be prohibitive. But the quantitative values placed on the quality and longevity of human life and certainly we cannot calculate the direct cost of illness, the amount spent on health care, medications and loss of productivity at work. Therefore, government must take steps to avoid certain diseases that are water related, resulting from mining activities at Itakpe by providing a comprehensive water treatment programme in the area to ensure portable and safe drinkable water for the people of Itakpe.

Recommendation

1. The people of the area should be educated on the need to stop using the water from the river especially from the downstream section. Presently majority of the inhabitants do not know the risk involve when they drink from the stream.
2. The location of mining activities such as beneficiation, should not be done close to the main source of water supply of the inhabitants, where it is done the mining company should be mandated to provide alternative sources of water to the community.
3. The community should pulled their resources together to sink industrial borehole, because the risk involve in drinking the water from the current shallow wells that serves as alternative source of water in the communities needs much to be desired.
4. The people should be taught and encouraged to harvest rain water during rainy season.
5. Local Government Authorities should partner with any willing NGO's to help provide portable water for the communities as this will still be cheaper compare to the cost of treating ailments that will arise from drinking a heavily contaminated water with heavy metals.

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