Assessment of Water Quality of a Mined Quarry Pit in Ekiti State (A Case Study of COPEK Group of Companies, Ikere Ekiti, State Nigeria

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Abstract

This study assesses the water quality of a mined quarry pit in COPEK Quarry, Ikere, Ekiti State, Nigeria. The research aimed to determine the physico-chemical parameters and inorganic ion concentrations in quarry pit water, river water, and borehole water. Water samples were collected from seven locations and analyzed for pH, electrical conductivity, turbidity, total hardness, bicarbonate content, and concentrations of calcium, magnesium, iron, zinc, chloride, phosphate, and nitrate ions. The results showed varying levels of these parameters, with some exceeding World Health Organization (WHO) permissible limits. The pH ranged from acidic to alkaline (4.9-8.4), while electrical conductivity indicated moderate to good conductivity (182.1-498 µs/cm). Total hardness ranged from soft to very hard water (52.60-172.30 mg/L). The presence of coliform bacteria in some samples indicates potential health risks. The study highlights the need for regular monitoring and management of water resources around mining areas to mitigate environmental and health impacts.

Keywords: Environmental Pollution, Mining Impact, Physico-Chemical Parameters, Quarry Pit Water and Water quality.

INTRODUCTION

In human living and their environment, there is always a link between the ways by which various activities takes place and water pollution of that habitat of living as a result of mining, release of industrial waste, smelting of mineral ore, incineration of fossil fuels particularly coal or petroleum, use of mineral loaded water for irrigation and chemical based pesticides and fertilizers; all this activities result from the advancement of industries and technological growth.

The main foundation or the root cause of pollution in mining area in Ikpeshi are from the Open pits, the area of waste deposition, the access road section of transport of mines, the plant sections such as the processing plants and run of mine ore, gangues and waste rock fragments.

A distinct deviating state of degradation of ground water has tendency to result from blasting activity which could result in a temporary vibration of the rock and could result in the new matrix rock geometry near working terrain of the mine. A blasting process can also actuate the previous occurring rock fissures to change to more porous , permeable or water saturated by shattering mineral fragments ; this could indirectly initiate lateral cracks located up up to several tens of hundreds meters away from the surface quarry which would lead to lateral or vertical leakage of pond/ lake mine drainage which would be nearby an abandoned subsurface mines to a beneath aquitard/ aquifer.

A pollution which would have cause water to get to a pollution state is one which there is a variation or alteration in composition or which have been initiated as a result of man's impact or effect so that it becomes mot useable or rather less suitable or not useful for any purposes for which it could have been useful or of benefit for human purpose(Panamello, 1973).

When water has been agreed to be polluted as a result of its natural composition been altered, in this case it is believed at the phase that actionable process can be taken on the state it has degraded to(Ezanabor, 1991). The phenomenon of environmental pollution and alteration of water nature by influence of other ion based/ dissolved substances or infusion of inorganic hazardous compounds are becoming a usual occurrence in most part of the developing world((Egboka 1989).

The inorganic chemistry of river waters, underground waters, surface waters, dug wells, its classifications, standard and application evaluations were carried out(Offodile, 1992) an experiment of a case study scenario in Nigeria, Africa. It is established that the effect of temperature caused by a heat energy to an extent is responsible for the water causing more dissolution of soluble ions and molecules. Molecules , ions and elements such Arsenic, Cadmium, Zinc, Lead, Chromium, manganese are termed poisonous elements. In this regard, their been in attendance in water as such that is above permissible measurement or limits rolled by the World Health Organization(WHO) , UNDP, and Such organization here in Nigeria ; the NAFDAC, which are standard organization established that such solute ions could cause a negative impact on human health especially the effect on the Central Nervous System. (Oteze, 1981).

The Copek mining companies have been established as one of the biggest quarry in Ekiti state and the most established mining company in Ekiti State, Nigeria having a Mineral Processing ability/ capacity of about 80,000tons/ day of processed stones

This research targets the assessment of water quality of a mined quarry pit in Copek quarry, ikere, Ekiti State.

The objectives of the research includes: i) Determination of physico chemical parameters such as total hardness, Electrical conductivity , Bi carbonate content and Total dissolved solid content in the quarry pit water, River sample water and Borehole water, ii) Determination of the total inorganic ions such as Ca+ ions, Fe+ ions, Zinc ions and the amount of bacterial found in quarry water, Bore hole water and River water , iii) Comparison of the results gotten from mine site water, bore hole water, river water with the Permissible standard limits of the World Health Organization.

The justification of the study is as thus : "Mining has been identified to comprise activities involving the production of minerals, quarry stones, producing rock / mineral materials which comprises of some dissolved solutes and solvents which when they permeates water bodies would alter the natural state of the universal solvent material and render it toxic which would invariably have lots of environmental and health impacts. The permeation of the creeps of this materials or its ions with water necessitate the thoughts of assessing water quality of mined quarry, borehole water nearby and river water around the site".

The scope of this study is restricted to Ikere in Ekiti State at the Copek quarry. The project is restricted to taking samples at the mine site, bore hole and rivers. Study is restricted to determination of PH, determination of Electrical Conductivity in water, determination of salinity as chloride water, determination of phosphate in water and the evaluation of the total dissolved solids among others.

Water quality degradation due to mining activities has become a significant environmental concern globally. The extraction and processing of minerals can lead to the release of heavy metals and other pollutants into water bodies, posing risks to human health and ecosystems (WHO, 2019).

Impact of Mining on Water Quality

Mining activities can result in the release of toxic substances, including heavy metals and acids, into water bodies (Akcil & Koldas, 2020). These pollutants can have devastating effects on aquatic life and human health. Studies have shown that mining can lead to increased levels of heavy metals in water, including lead, mercury, and arsenic (Jaishankar et al., 2020). The impact of mining on water quality can be long-lasting, with some studies suggesting that water pollution can persist for decades after mining activities have ceased (Ochieng et al., 2022).

Water Quality Assessment

Water quality assessment is crucial in determining the impact of mining on water bodies. Various studies have used different parameters to assess water quality, including pH, electrical conductivity, total dissolved solids, and heavy metal concentrations (WHO, 2022). The use of water quality indices

(WQIs) has also been employed to evaluate the overall quality of water bodies (Sarkar et al., 2022). WQIs can provide a comprehensive picture of water quality, taking into account multiple parameters and their impact on human health and ecosystems.

Environmental Pollution

Environmental pollution due to mining activities can have long-term effects on ecosystems and human health. The release of pollutants into water bodies can lead to bioaccumulation and biomagnification, posing risks to aquatic life and humans who consume contaminated water or fish (Islam et al., 2023). Mining activities can also lead to soil pollution, affecting agricultural productivity and ecosystem health (Khan et al., 2023).

Remediation and Mitigation

Various remediation and mitigation strategies have been proposed to address water pollution due to mining activities. These include the use of natural and engineered wetlands, chemical treatment, and biological remediation (Khan et al., 2023). The implementation of sustainable mining practices and regulations can also help minimize the impact of mining on water quality. Studies have shown that the use of best management practices (BMPs) can reduce the release of pollutants into water bodies and mitigate the impact of mining on ecosystems (Ochieng et al., 2022).

METHODOLOGY

Strategy survey or rather observation of the study area was carried out to identify and locate strategic positions to which the samples were collected to ensure a reliability , precision and accuracy of results. Plastic bottles narrow necked containers were utilized for the collection of water samples at each of the location. Water samples(Seven) were taken at the mine site, water samples taken from borehole and water samples taken from river water.

The plastic bottles were rinsed well with distilled water before collection of samples. This was done for each successive location where samples were collected.

The samples were corked tightly and well labelled based on their location and numbers taken. Thereafter the samples were kept in a refrigerator at a temperature close to 4^0C to avoid bacterial development or replication hitherto been taken to the laboratory for the targeted analysis after 24 hours.

a)Determination of PH in water :

The measurement of the PH of the water samples collected requires using a PH meter of M- Tester 1, Buffer solutions of PH 4.00 and 10.0 were used and Beaker. Hitherto the actual measurement, a calibration was done on the PH meter and the below process was observed to take the PH measurement of the water sample:

i) The PH meter electrode was rinsed with distilled water

ii) An 200ml of water samples in a clean 200 ml capacity beaker used.

iii) The electrode end of the PH meter was introduced in the sample of water and PH measurement taken thereafter

iv) Then, both the PH meter electrode simultaneously with the sample were rinsed with water

iv) All the PH values were recorded and tabulated in the results session

b)Determination of the Electrical Conductivity of the water Sample

The ability of the tested sample to carry an electric charge or an electric current. An electrical conductivity meter (P 65) with 0.01M NaCl solution was applied. The conductivity meter was calibrated to ensure its accuracy for measurement is guaranteed. The following procedure were followed:

i)The conductivity meter probe was rinsed with clean water followed by the water sample itself.

ii)About 200ml of the water sample is poured into a clean beaker of 200ml

The probe of the meter then inserted in to the sample in the beaker, thereafter press the READ button and then wait for an equilibrium state rading

Therefore record the EC value.

c) Determination of turbidity and Color using Lovibond Comparator and Turbidity Meter

The turbidity of the water sample is taken using Turbidity meter probe after rinsing with water to measure the turbidity of the water sample while the Lovibond comparator ; its probe after rinsing shows the color of the sample on measurement.

d)Determination of phosphate in the various water sample

The use of HACH DR 2000 , 20 ml pipette, Hot plate, 100ml volumetric flask, 50 ml cuvette, 300 ml round bottom flask were required to carry out the experiment with the following chemical reagent: Ascorbic acid (25% w/v) solution, ammonium molybdate – antimonyl solution 2500mg/l of phosphate standard stock solution, a solution of Pecchloric acid, KOH solution 6Molar and Phenolphtalin indicator.

An oxidation method using oxidation state/ number approach where the state keeps track of electrons gained when a substance is reduced and the electrons lost when a substance is oxidized,

Multi tube test(APHA 9222A) including method based upon reaction of the nitrate ion with brucine sulphate in a 13N sulforic acid solution at a temperature of 100^0C. The color of the resulting complex is measured at 410nm.

Table 1 Results of laboratory data's with samples analysed

Sample Code	PH	Conductivity (μs/cm)	Color (Lu)	Turbidity (N.T.U)	Ca^{2+}	Mg2+	Chloride (mg/l)	Phosphate	Nitrate
QWS1	5.02	498	0	1.43	20.03	7.72	92.05	0.16	0.08
QWS2	5.20	458	1	1.57	10.56	3.44	63.14	0.08	0.04
QWS3	5.1	478	0	1.38	14.43	4.54	74.24	0.12	0.03
QWS4	4.9	468	0	1.16	7.52	1.83	53.84	0.14	0.01
BHW1	7.81	182.1	0	1.72	5.21	1.40	32.00	0.95	0.02
RWS1	8.32	366	1	2.31	15.62	4.88	81.05	0.20	0.04
RWS2	8.35	356	1	4.16	21.40	1.26	79.20	0.05	0.03
RWS3	8.40	376	1	8.73	6.60	2.72	77.10	0.25	0.02

Table 2 Laboratory Results of TDS, Bi-carbonate, Fe2+, Zn3+, Coliform & TDS

Sample Code	Total Hardness	Bi Carbonate	Iron (Fe)	Zinc(Zn)	Coliform Count	Total Dissolved Solids
QWS1	172.30	56.35	0.12	0.06	3	254
QWS2	98.20	32.74	0.14	0.08	3	134
QWS3	109.9	36.55	0.18	0.06	1	185
QWS4	71.05	22.74	0.11	0.04	1	120
BHW1	52.60	22.53	0.11	0.04	5	94
RWS1	111.82	40.00	0.14	0.07	12	188
RWS2	121.38	53.52	0.10	0.06	7	232
RWS3	101.27	50.42	0.11	0.06	0	262

Table 3 Comparison of the obtained values with the World Health Organization Standard (WHO, 1994)

Parameter	Higher Desirable (Mg/L)	Maximum Permissible Level(Mg/L)	Range of Values Obtained from Analysis	Remarks
PH	7.0-8.9	6.5 -9.5	4.90 – 8.40	It is acidic to Alkaline
Conductivity	900(*u*s/cm)	1200(*u*s/cm)	182.1 – 498	
Total Hardness	100	100	52.60 – 172.30	Soft to Very Hard
Magnesium	20	20	1.26 – 7.72	Highly low
Calcium	0.01	0.07	5.21 – 21.40	At High Concentration
Iron	1.0	3.0	0.10 – 0.18	Okay
Turbidity	5.0	5.0	1.16 – 15.32	Only RWS3 is not Suitable
Zinc	0.01	3.0	BDL-0.08	Suitable
Total Coliform	Not Allowed	Not Allowed	0 – 12	Only 1 Sample is Okay
Total Dissolved Solids	-	500	94 - 262	Okay

*United State Environmental Protection Agency, 2012. . **National Agency for Food, Drug Administration and Control . BDL: below detection limit.

Table 4. Water classification according to its hardness

HARDNESS	TYPES OF HARDNESS
0-60	Soft Water
61-120	Moderately Hard Water
121 – 180	Hard Water
Greater than 180	Very Hard water

DISCUSSION:

The result has been able to show Total Hardness, Turbidity, Magnesium and calcium are sort of high in some samples

Phosphate, Chloride, Hrdness, Conductivity, PH , Zinc and copper existed in considerable concentration which are usually within the average nominal values as to be compared to World Health Organization, NAFDAC and United State Environmental Protection Agency (USEPA) limit Values.

The colour of samples examined are within the range of hazen unit measurement.

The PH of the quarry sample water (QSW), Bore Hole Sample water (BHW) and River Sample Water(RSW) ranges from 4.9 to 8.40 which interprets that PH is generally acidic to alkaline.

The measurement of electrical conductivity ranges from 182.1 to 498 *u*s/cm which depicts the samples are good or moderate good conductors of electricity.

The result of Total Hardness of the sample of the Quarry Water Sample (WS), Borehole Sample Water(BSW) and the River Water Sample(RWS) ranges from 52.60 -172.30 which depicts that the hardness is within soft water, moderately hard water and very hard water.

The presence of coliform count bacterial from the sample collected waters in the seven obtained samples indicates that the water has contacted with the faecal material of human/ other animals. That's an indication of capacity to health risk that would occur for any person .in contact to this water. The values ranges from 0 -12. It is to be noted that no faecal materials are okay in drinking water.

The study assessed the water quality of a mined quarry pit in Copek Quarry, Ikere, Ekiti State. The results indicate varying levels of water quality parameters, with some exceeding World Health Organization (WHO) standards.

PH and Electrical Conductivity
The pH range (4.9-8.40) suggests that the water samples are acidic to alkaline. The electrical conductivity values (182.1-498 µs/cm) indicate moderate to good conductivity.

Total Hardness and Total Dissolved Solids
The total hardness values (52.60-172.30 mg/L) categorize the water as soft to very hard. Total dissolved solids (TDS) values (94-262 mg/L) are within acceptable limits.

Heavy Metals and Bacterial Contamination
Iron and zinc levels are within permissible limits. However, the presence of coliform bacteria in some samples indicates potential health risks due to fecal contamination.

Comparison with WHO Standards
The study reveals that some parameters, such as pH, total hardness, and bacterial contamination, deviate from WHO standards. These findings suggest potential health implications for individuals consuming or using this water.

CONCLUSION AND RECOMMENDATIONS

Conclusion
This study assessed the water quality of a mined quarry pit in Copek Quarry, Ikere, Ekiti State, revealing varying levels of water quality parameters. Some parameters exceeded World Health Organization (WHO) standards, indicating potential health risks. The presence of coliform bacteria in some samples suggests fecal contamination, emphasizing the need for regular monitoring and treatment. The study's findings have significant implications for water management and public health, highlighting the importance of prioritizing water quality improvement initiatives.
This study provides valuable insights into the water quality of the mined quarry pit and surrounding water sources. The findings highlight the need for continued monitoring and improvement of water quality to protect public health.
The study's results have significant implications for water management and public health. Regular monitoring and treatment of water sources are essential to ensure safe drinking water. Stakeholders, including government agencies and local communities, should prioritize water quality improvement initiatives.

Recommendations
1. Regular Water Quality Monitoring: Implement a regular water quality monitoring program to track changes in water quality parameters and identify potential sources of contamination.
2. Water Treatment Strategies: Develop and implement effective water treatment strategies to ensure safe drinking water for local communities.
3. Waste Management Practices: Enhance waste management practices in the mining area to prevent contamination of water sources.
4. Community Education: Educate local communities on water safety and hygiene practices to prevent waterborne diseases.
5. Collaboration and Policy Implementation: Encourage collaboration between stakeholders, including government agencies, mining operators, and local communities, to develop and implement policies that prioritize water quality improvement and protection.

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