

Research Article

Impact of Mining Activities on Iju River in Ado-Odo Otta Local Government Area Ogun State Southwest Nigeria

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Abstract

Environmental degradation occurs as a result of mining activities and can lead to deterioration of water quality. From this study, water samples were collected from upstream, midstream, and downstream locations along Iju river in Ado-Odo Otta Local Government Area. Samples were analyzed for Physical, Chemical and Microbial parameters. The result showed that, pH (5.9-6.14) was lower than the World Health Organization guideline, which indicates acidic conditions of the water quality as a result of mining activities. Biochemical Oxygen Demand, Total Dissolved Solids levels were also high indicating the presence of pollution. Total hardness exceeded the permissible limits, thereby posing health risk to human health. The heavy metal result showed that: Iron (1.38-1.89mg/L), Manganese (10.73-15.37mg/L), Chromium (0.31-0.34mg/L) and Lead (0.33-0.57mg/L) were higher than the permissible guideline, which causes neurological, carcinogenic risk and gastrointestinal issues in human. Microbial contamination occurred at the 3 sections of the river, with total bacteria count ranging from (6.9×10^6 - 10.6×10^6 cfu/mL), total coliform count (4.6×10^6 - 6.2×10^6 cfu/mL), and total E. coli count (3.6×10^6 - 5.1×10^6 cfu/mL) which exceeded the permissible guideline which can cause deleterious health effect on human health. Thus, there is an urgent need to monitor, and encourage advanced water treatment to mitigate mining's activities on the Iju River.

Keywords

Surface, Water, Quality, Mining, Pollution, Health

1. Introduction

Mining is an ancient activity that has been integral to human progress. The history of mining dates back to prehistoric times when early humans extracted stones and metals for tools and ornaments. Early mining activities included the extraction of flint, gold, and copper, which were used to produce basic tools and jewelry [5]. Thus, the physio-natural and socio-environmental ecosystems have continually exhibited resilience and adaptability in response to these activities both in long term and in short terms [1]. Degradation of water

quality, alteration of river morphology, destruction of aquatic habitats, and loss of biodiversity has posed a lot of health risk in our environment [9]. The process of mining undermines infrastructures such as bridges and roads making them vulnerable to collapse. Additionally, the physical disruption of beds can lead to increased turbidity, reducing water quality and affecting aquatic life [2, 6].

Understanding the intricate relationship between mining activities and human health is crucial for developing sus-

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Received: 21 March 2025; **Accepted:** 28 March 2025; **Published:** 7 July 2025



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tainable management practices that protect both the environment and public health from climatic factors affecting them [16]. This research seeks to contribute to the body of knowledge on the environmental and health impacts of riverbed sand mining, providing a foundation for future studies and policy development aimed at mitigating these effects.

Environmental changes have direct and indirect impacts on human health, necessitating a comprehensive understanding of how mining activities, specifically riverbed sand mining, influence the health of local populations [7].

The environmental and health impacts of riverbed sand mining requires a comprehensive approach involving scientific research, community engagement, and policy intervention, that brings about changes in water quality and aquatic life [2]. This study aims to evaluate the effects of sand mining on the Iju River's water quality and understand the implications for human health. By collecting and analyzing samples from various points along the river, this research will provide valuable insights into the spatial variations in water quality and the specific health risks posed by mining activities.

The discharge of pollutants, including heavy metals and sediments, from mining operations into rivers leads to severe degradation of water quality, sediment composition, and biological diversity [11].

These changes not only disrupt the ecological balance but also pose serious health risks to human populations and affect the sustainability of aquaculture operations [10]

Despite the known impacts, there is a need for a comprehensive analysis to fully understand the extent and nature of these effects, and to develop effective mitigation strategies

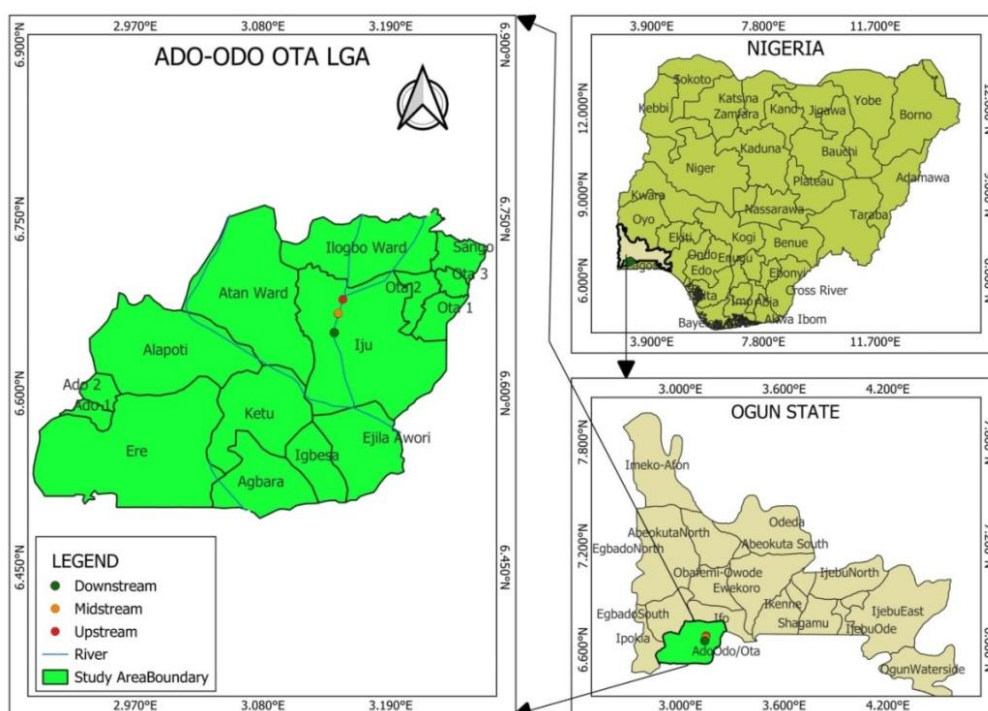
and remedies for sustainable management. Hence, this research aims at assessing the effect of mining activities on the Iju River in order to propose strategies for sustainable mining practices that minimize negative effects on the river and human health.

2. Materials and Methods

2.1. Description of the Study Area

The study was conducted on the Iju River, which flows through the Ado-Odo Ota Local Government Area in Ogun State, Nigeria. This region is located between latitudes 6°36'N and 6°41'N and longitudes 3°21'E and 3°52'E [4]. It is characterized by a mix of urban and rural settings, with the river playing a crucial role in the socio-economic activities of the surrounding communities. The river serves as a vital water source for domestic, agricultural, and industrial uses, making it an essential resource for the local population [3].

The climate of the Ado-Odo Ota area is typically tropical, with distinct wet and dry seasons. The wet season, which lasts from April to October, brings heavy rainfall, contributing to the river's flow and water levels. The dry season, from November to March, is marked by reduced rainfall and lower water levels. The average annual rainfall ranges from 1,200mm to 1,500mm, while temperatures typically range from 24 °C to 30 °C throughout the year.



Source: (Cartographic Laboratory FUNAAB, 2024)

Figure 1. Map of the study area.

The natural vegetation of the Ado-Odo Ota area is characterized by tropical rainforest, although much of the original forest cover has been replaced by secondary vegetation and agricultural lands. Common plant species include oil palm (*Elaeis guineensis*), rubber (*Hevea brasiliensis*), and various hardwood species. Riparian vegetation along the Iju River includes grasses, shrubs, and trees that help stabilize the riverbanks and provide habitat for wildlife [8].

2.2. Sampling Collection/ Procedure

Water samples were collected from three points along the Iju River: upstream, midstream and downstream. The upstream was chosen for its relatively undisturbed condition. The midstream site was selected at the active mining area, where significant activities were observed, while the downstream site was located beyond the mining area to assess the cumulative impacts of the mining on water quality.

Systematic sampling technique was used to ensure consistent coverage across the river. Sampling points (locations)

were spaced at regular intervals, with an average distance of 726.43meters (72,643cm) between collection points. This method was chosen to provide a representative sample of the river by capturing variations in water quality along its length. At each site, water samples were collected at a depth of 30cm below the surface using pre-cleaned polyethylene bottles, which were rinsed three times with river water before the final sample collection to avoid contamination. The systematic sampling approach was selected because it ensures a uniform distribution of sampling points while minimizing bias, making it an efficient strategy for studying changes over a large area. This method allowed for accurate and reliable water quality assessments across the river.

2.3. Statistical Analysis

Descriptive statistics was employed for the set data and they are as follows: mean, standard deviation, range and coefficient of variation (CV). The quantitative results are recorded and are done by SPSS (version 23) software.

Table 1. Results of the Physical and Chemical Parameters obtained from Iju River during the Dry Season.

Parameters	Unit	Upstream	Midstream	Downstream	WHO Guideline
pH	-	6.14	5.90	5.99	6.5 – 8.5
Temperature	°C	32.5	34.6	35.4	30-35
EC	µs/cm	520	629	574	1000
TDS	mg/L	3250	3460	3540	1000
Total Hardness	mg/L	7500	1500	1260	500
Total Alkalinity	mg/L	20	2	8	100
Calcium	mg/L	210	504	170	200
Magnesium	mg/L	729	996	1243	50
DO	mg/L	3.52	5.12	4.26	5
BOD	mg/L	18.16	51.62	28.14	3
Sodium (Na ⁺)	mg/L	8.92	12.03	8.99	50
Potassium (K ⁺)	mg/L	2.19	4.36	2.83	2
Chloride	mg/L	180	100	165	250
Turbidity	NTU	132.4	816.8	141.3	5
Nitrate (NO ₃ ⁻)	mg/L	3.23	3.61	1.63	10
Sulphate (SO ₄ ⁻)	mg/L	1.41	1.63	2.01	200

Number of Samples = 3

NOTE: EC: Electrical Conductivity, TDS: Total Dissolved Solids, DO, Dissolved Oxygen, BOD. Biochemical Oxygen Demand

Table 2. Results of the Heavy Metals Parameter obtained from Iju River during the Dry Season.

Parameters	Unit	Upstream	Midstream	Downstream	WHO Guidelines
Fe	mg/L	1.38	1.89	1.46	0.3
Cu	mg/L	0.07	0.09	0.07	2
Mn	mg/L	10.73	15.37	12.14	0.4
Zn	mg/L	0.49	0.78	0.51	3
Pb	mg/L	0.33	0.57	0.41	0.01
Cr	mg/L	0.31	0.34	0.31	0.05

Table 3. Results of the Microbial Parameter obtained from Iju River during the dry Season.

Parameters	Unit	Upstream	Midstream	Downstream	WHO Guidelines (2017)
TBC * 10 ⁶	cfu/ml	8.2	6.9	10.6	0
TCC * 10 ⁶	cfu/ml	4.6	6.2	5.9	0
TEC * 10 ⁶	cfu/ml	3.6	3.9	5.1	0

Number of Samples = 3

NOTE: TBC: Total Bacteria Counts, TCC: Total Coliform Counts, TEC: Total E.coli Count

3. Discussion

The findings from the study of Iju river showed the impacts of mining activities. It was observed that the pH values, ranged from (5.90 - 6.14) which is an indication of the acidic conditions that can adversely affect aquatic life and water quality [13] Acidity in waters can lead to corrosion, increased metal solubility and further exacerbating contamination issues [20].

The temperature increase from 32.5 °C to 35.4 °C which can result to ecological imbalance and affect species that are sensitive to temperature changes [19]. Although electrical conductivity (EC) values remained within acceptable limits.

The value of Total hardness, Magnesium and Potassium were higher in the upstream, midstream and downstream. Calcium has a high value only in the midstream, while the values for the upstream and downstream fell within the permissible limit for drinking water.

The value of Total dissolved solids (TDS) exceeded the WHO guideline for drinking water which causes significant pollution, as a result of mining activities which runoff from the river [15].

Dissolved Oxygen (DO) levels was below the WHO guideline of 5mg/L. This indicate potential hypoxic conditions, which can lead to fish kills and loss of biodiversity [17] The high Biochemical oxygen demand (BOD) content in the water quality suggests organic pollution, which is likely to

occur from both natural and anthropogenic sources.

Heavy metal concentrations, particularly iron, manganese, lead and chromium were found to exceed WHO guidelines, indicating severe pollution [12]. The presence of these metals can have detrimental effects on both human health and aquatic ecosystems [14] The findings highlight the urgent need for effective monitoring and management strategies to mitigate the environmental impacts of mining activities on the Iju River.

Microbial contamination, occurs as result of increase in Total bacterial counts, Coliform count and E. coli which exceeded the permissible guideline as a result of the mining activities which poses serious public health risks in human using the water for domestic purposes [21] This contamination can be attributed to inadequate waste management practices in mining areas [18].

4. Conclusion

This study evaluated the physical, chemical, heavy metals, and microbial contents of water from upstream, midstream, and downstream points along Iju river. The findings indicates environmental degradation and potential health hazards due to mining activities in Iju river.

The pH upstream, midstream, and downstream values were acidic, which is known to result in corrosion of pipes conveying potable drinking water. Electrical conductivity (EC) levels were within the permissible limit for drinking water.

Total Dissolved Solids (TDS) exceeded the WHO guidelines for drinking water, indicating a significant presence of dissolved minerals, which could lead to chronic health issues such as kidney stones in human if the water is consumed over a prolonged period without proper treatment.

The high concentration of Biochemical Oxygen Demand (BOD) observed in the water indicates a significant presence of organic pollutants.

The result of heavy metal showed that Iron, Manganese, and Lead were higher than the WHO guidelines, indicating severe contamination. These metals are known to cause various health issues, including neurological damage, particularly in children. The presence of Chromium, although less in concentration than other metals, still poses carcinogenic risk in human health.

The microbial analyses were higher in all the sampling points, for Total Bacterial Count (TBC) Total Coliform Count (TCC) and Total E. Coli (TEC). This could be as a result of faecal contamination and can cause a high risk of waterborne diseases, which affects human health.

Abbreviations

EC	Electrical Conductivity
TDS	Total Dissolved Solids
DO	Dissolved Oxygen
BOD	Biochemical Oxygen Demand
TBC	Total Bacteriological Count
TCC	Total Coliform Count
TEC	Total E.Coli
Fe	Iron
Cu	Copper
Mn	Manganese
Pb	Lead
Cr	Chromium

Conflicts of Interest

The authors declare no conflicts of interest.

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